Feilden's Magazine

THE WORLD'S RECORD OF

Industrial Progress.

No. 15. OCTOBER, 1900. Vol. 3. No. 4.

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All communications to be addressed

FEILDEN PUBLISHING Co.,

Temple Chambers, Embankment, London, E.C.

Telegraphic Address—"IMPREGNATE, LONDON."

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THE EDITOR will be pleased to consider Literary Contributions dealing with subjects within the purview of this Magazine, and to make satisfactory arrangements with Contributors if MSS. be accepted for publication. High-class engravings from photos and drawings will be prepared free of cost to the writer

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This issue is the fourth number of Vol. III.

Traffic Facilities.

No doubt people in this country already begin to show an awakening interest with regard to improved facilities for locomotion. Even London is being aroused from its lethargic slumbers. Already two low-level railways are in operation, and others are in course of construction; the Metropolitan railways are to be reformed, electric tramway systems are being established and talked of, and, more wonderful still, some of the sleepy old southern railway companies are actually proceeding to widen their lines and to increase the dimensions of their stations built to suit the traffic of a bygone generation. All this is satisfactory so far as it goes, but it does not go far enough. With strange incongruity the land which encourages foreign industries by free trade fetters some of its own by taxation, and hampers others by the perpetuation of monopolies. So far as means of locomotion are concerned, there are no restrictions upon the multiplication of vehicles of an obsolete character, but it is extremely difficult to introduce any which conform with modern ideas. Things are different in the United States, where there is free trade in railways and tramways. We do not mean to imply that American railways are managed better than some of our own lines, but there are undoubtedly others which would be vastly improved by a little wholesome competition. It is when we consider tramways that the city and suburban services of America show to so much advantage. As a recently returned traveller remarks in a communication to the *Times*: "Wherever one goes in the more settled States, and also in many parts of those not thickly populated, as one approaches a town of any size, there are the electric railways radiating for miles out into the surrounding district. They run along the main streets of the cities and out into the country, over roads hardly formed, across fields, upon narrow ledges scarped out of precipitous hill-sides, up banks so steep as to be inaccessible to horse traction, over slender viaducts and river bridges—in fact, they are covering the country with a network of communication that is making more rapid changes in social and economic conditions than has been witnessed since the introduction of the steam locomotive." This is a striking picture, which shows the handiwork of a people who know the shortness of human life and appreciate the value of time. American citizens, blessed with a rapid tramway service like this, can either devote an hour or two every day to work, or can enjoy a little more time at home than is possible for the average city man who lives in the suburbs of London. Railway stations in London are ingeniously placed so that many regular travellers cannot reach them in less than half an hour; then, after waiting for a train, it not infrequently takes another half-hour to travel four miles. Of course there are sometimes alternative omnibus or tramway routes, but on these an hour will be spent in covering the same distance, providing always that the intending traveller can fight his way into the vehicle. We need not dwell on the deficiencies of traffic facilities to and from the suburbs of London; they are doubtless only too well known to many of our readers. And every effort made by enterprising individuals to provide improved means of transit is obstinately opposed, both by monopolists and by narrow-minded public bodies. Street traffic in American cities is aided by similarly superior facilities. In every main thoroughfare electrically propelled cars are to be found, and, moreover, they travel at a respectable speed. Consequently it is possible for a business man to make an appointment by telephone to call at a given address, perhaps a mile or two distant. He knows that a car can be

found which will take him very close to his destination in a few minutes, and therefore he does not shrink from the journey as people almost invariably do in London. To American visitors our street traffic is simply a marvel. It is also a marvel to them how we conduct business at all under such conditions. Of course many American cities have broader streets than our own, but, taking Boston as an example, we find plenty of narrow thoroughfares, in which the traffic was terribly impeded until sensible measures were adopted. Of these we gave some brief details in our June issue. The difference between this country and the United States seems to be that we grumble at but continue to suffer things known to be wrong, whilst the American wastes no time in plaintive wailing, but resorts promptly to action.

There is not the slightest reason why we should not do the same. Municipalities should be compelled by Parliament either to permit enterprising companies to establish the services necessary for the inhabitants, or to undertake the work themselves. Sanitary and other municipal systems are already compulsory, and we are strongly of opinion that means of transport should likewise be so. Further, there ought to be a permanent Commission or Department, constituted for the specific object of inquiring into the needs of different places, of deciding what measures could most appropriately be adopted, and of compelling their adoption. If private enterprise should be lacking, then let the local authorities be made to supply the deficiency. The essential thing is to get the work done. How it is to be done is merely a matter of detail, but we are fully convinced that industrial enterprise would be amply evidenced as an immediate result of the removal of the senseless obstacles which are so dear to many public bodies, and which are viewed with so much complacency by Parliament. Apart from its effect upon trade generally, the backwardness of transport facilities reacts upon mechanical and electrical engineering industries. For instance, for what reason is it that British engineers appear to be quite incapable of furnishing the plant for any large installations of electric tramways or railways? It is well-known that the contract for the Glasgow tramway engines was secured by the Edward P. Allis Company, of Milwaukee. The same firm has furnished the new engines for the City of London Electric Lighting Company at Bankside, and also the engines for the generating station of the Central London Railway at Shepherd's Bush. And still more lamentably striking is the fact that nearly the entire equipment of the last-mentioned railway comes from America. Let us now look for a moment at some of the things which have been, and are being, done by this one firm of American engine-builders. Amongst the countries to which engines of large size have been supplied the following may be mentioned:—Australia, Argentina, Austria, Canada, Chili, England, Germany, Ireland, Mexico, New Zealand, Sandwich Islands, Scotland, Spain, and South Africa. Moreover, no less than 50 of the United States have been supplied. Nine engines of 1,000 h.p. were laid down in 1889 for the Boston Street Railway Company; eight pairs of compound engines, capable of developing 12,000 h.p. each, or 96,000 h.p. collectively, are on the point of being installed in the central station of the New York elevated railway; eleven sets of engines for the generating station of the New York street railways are now being completed, representing a collective energy of 77,000 h.p. Besides these contracts, the E. P. Allis Company has quite recently been engaged on engines for the Pittsburg Electric Tramways, the Richmond (U.S.A.), Norfolk (U.S.A.), and the Lynn (U.S.A.) electric railroads, and in addition upon thirty-four blowing engines of large dimensions. These brief data are sufficiently startling, but their sting is to be found in the fact that a firm whose works are at least 1,000 miles from the nearest American seaport should be able to obtain contracts over the heads of our own engineers. At present the Americans do not particularly want export orders for engines of this class. That they get them is clear evidence of our own unpreparedness in some form or other. The question

we now ask of our British manufacturers is, what will be your position when the American engine-builder begins to seek in earnest for foreign trade?

In electrical engineering the United States are able to furnish us with equally striking matter for consideration, but we will refrain from entering upon details. With regard to locomotive steam engines, it is very difficult to institute comparisons between British and American makes, because the conditions are so different in the two countries. In Great Britain the demand for locomotives comes chiefly from some of the smaller railway companies and from foreign markets. On the other hand, the American maker supplies practically all the railway companies of his own country, and is also open to undertake export business. The absence of locomotive works in connection with American railway systems necessarily gives the engine-builder a great advantage, for he is able to establish very extensive workshops, and to equip them on a most elaborate scale. Consequently orders can be executed with exceeding rapidity, and at minimum prices. As indicating rapidity of execution, the following example is interesting. A demand for nine locomotives was received by the Baldwin Locomotive Works, Philadelphia, the specified time of delivery being 14 days from receipt of the order. Although the design was familiar to the firm, none of the requisite materials were in stock, and the shops were very full of other work. The plates were immediately ordered by telegraph, and an engineer was sent by train the same day to verify the particulars and to perform the usual tests. In Great Britain it would probably be impossible to obtain delivery of the plates for three or four weeks, or perhaps months. In this case, however, they were promptly forthcoming, and all the engines were sent off within the specified time. Owing to the conditions to which we have previously referred, this is probably a feat entirely beyond the power of any British firm. Again, the American possesses an advantage which is important in its bearing upon foreign trade. He is willing to adapt his patterns to suit the requirements of buyers, and, generally speaking, we are not. This is an old tale. For generations past we have been accustomed to dictate to the world as to what ought to be bought, and what ought to be used. No doubt we are a very superior sort of people, and some of those who conduct industrial works in the provinces are exceptionally superior, but foreign nations and our own colonists are beginning to run alone, and will not submit to dictation as they once did. The result is, that when the intending buyer is told "We only make these goods our own way, and if you want them different you had better go somewhere else," he goes, and in nine cases out of ten to the United States. Proof of this is furnished by figures relating to various industries, not excepting those with which we are for the moment concerned.

Besides indirectly hindering the development of mechanical and electrical industries, the action of our obstructionist authorities also has a prejudicial effect upon the production of steel for rails and structural work, and acts as a brake on the extension of trade in car building for tramways and light railroads. It also prevents thousands of working men from obtaining lucrative employment in connection with the construction of such highways of communication. Knowing how tenderly the working classes are cared for by members of elective bodies, we are surprised that such persons should generally be so anxious to injure their *protégés* by continuing to obstruct enterprises of the kind now under consideration.

Leaving ordinary railways out of the question, we find that electric rail and tram roads have multiplied wonderfully in the United States during recent years. At the present time there are more than 15,000 miles of electric lines in operation, and more than 40,000 electric cars. It is doubtful whether 350 miles of line are running in this country, and the utter inadequacy of this sum total is due, not to lack of ability or enterprise on the part of the commercial and industrial classes, but chiefly to short-sighted and needlessly harassing restrictive legislation, and to the obstinate opposition of county councils, vestries, and district councils.

Utopian Sewage Treatment.

A report was recently presented to the Mersey and Irwell Joint Committee, by Mr. R. A. Tatton, chief inspector, which affords an interesting commentary on the present state of the sewage problem. Although a slight measure of success is recorded it can hardly be said that the total result of the Committee's operations is encouraging. In spite of the combined efforts of engineers, chemists, and inventors of every degree of ingenuity and enthusiasm, the problem of how to treat the sewage of large towns seems to be almost as far from a practical solution as it was twenty years ago. The incentives to progress have not been wanting; wealth and honour would in all probability reward the discoverer of any system which should comply with legal requirements at anything like a cost which would not prove an unreasonable burden on the community; but up to the present it cannot be claimed that a solution of the difficulty has been found for the larger manufacturing towns, where suitable land for irrigation purposes is not obtainable. It may be thought that this is rather over-stating the facts, but the figures given in the report referred to will bear out such a statement. During the two years 1898-9 samples of the effluents were analysed from sixty-nine different sanitary authorities. Of these authorities six are county boroughs, and it is noticeable that four of them never attained to the standard laid down by the Joint Committee, while two of them only attained it occasionally. Out of nine non-county boroughs, only one was consistently up to the standard, while of the urban district councils, fourteen out of forty-seven, and of the rural district councils, three out of seven passed the ordeal.

The difficulty does not lie merely in finding a method of converting sewage into comparatively pure water. That can be done in various ways well known to scientists. What is wanted is a method which shall be practically available under ordinary working conditions, and at a reasonable expense. It is not a difficult matter to deal with a few gallons, or a few hundreds of gallons of sewage in a laboratory and convert it into fairly pure water, but it is quite a different thing when millions of gallons per day are to be so dealt with, not in a scientifically equipped laboratory under the eyes of trained experts, but in a sewage treatment works manned by ordinary skilled or unskilled labour. The question of cost is one which cannot be eliminated from any practical consideration of the matter. The policy of the existing legislation is also to blame for much of the present want of progress. Time was when the sewage of our towns and villages was turned freely into the nearest brook or river, and in consequence the once limpid streams became noisome sewers, a stink and an abomination. Then, very properly, came a period of legislation—Public Health Acts, the Rivers Pollution Act, County Councils, Joint River Boards, were brought to bear on offending authorities, and standards of perfection, varying with the sources from which they emanated, were created for the guidance of the luckless authorities who were expected to attain them. To these standards all must accord, or suffer the pains and penalties laid down for their forcible conversion to righteousness. No matter what the quality of the sewage to be dealt with, or the nature of the stream into which the effluent was to be discharged; no matter what the facilities might be for obtaining land for irrigation purposes, all must fit the Procrustean standard laid down, and, even in the case of an application to the Local Government Board for borrowing powers, must provide for treating the sewage in certain specified ways, although, as in one recent case, it is proved that such a method may be actually detrimental to the result.

Now, large and rich cities and boroughs which can afford to provide expensive works for sewage treatment are, in many cases, just those which by natural causes are debarred from finding suitable land within a distance of some miles, and at the same time these large municipalities are sufficiently wealthy to receive with equanimity the threats and even fines to

which they may be subjected for non-compliance with the requirements of the law. Consequently it is the smaller authorities who are made to suffer—to encourage the others—and we are presented with the incongruity of two or three harassed communities saddling themselves with the burden of expensive works and doing their best to purify their sewage, while higher up the stream into which they discharge some immense town continues to discharge its pestilential filth in such quantities as to nullify the good effects of their little efforts. Examples of this state of things will readily occur to those who are familiar with the question. Morally, of course, there is pleasure in such well-doing, but the aphorism that virtue is its own reward is one which is looked upon with little favour in municipal matters when it touches the pockets of the ratepayers.

The fact is, the legislation asks for too much at once. To try to raise sanitary authorities at one stroke to a Utopian perfection in this matter is as though one should try to convert a dipsomaniac to teetotalism by absolutely cutting off alcoholic liquor, or to cure an inveterate smoker by rigidly denying the slightest indulgence in tobacco. Such a course does not commend itself to modern judgment. Is not the whole system of rigid and inflexible standards a faulty one? It seems more reasonable to think that better results might be obtained by aiming at a gradual improvement all along the line rather than by trying to convert the sinners right away, while their neighbours are permitted to undo their good works as soon as they are performed. What reasonable inducement is there, other than that of compulsion, to lead any town to spend money in producing a pure effluent, when that effluent has to be discharged into a stream which is little or no better than crude sewage? A more likely method of obtaining a general improvement would probably be found in some system of demanding a slight improvement in the effluent of every authority rather than a great and almost impossible degree of purification in a few cases only. Such a system might be based on the relation between the respective conditions of the effluent and the stream into which the effluent is discharged. Supposing that it were made compulsory for every effluent to be a little better than the stream—say, that it should contain 10 per cent. or 20 per cent. less organic impurities—it is obvious that without any very great burden being imposed a decided change might soon be brought about in the condition of many of the smaller rivers and streams. In the few cases where bad effluents are turned into the upper reaches of a pure stream perhaps such a requirement as the above would be too stringent. In such cases it would suffice to follow the present system of defining an amount of pollution which must not be exceeded, but as matters now stand most towns receive their outlet streams already polluted with the sewage of other towns further up the watershed, and it seems an absurdity to the non-legal and non-official mind to be told that pollution takes place, because, perhaps, in every twenty gallons of effluent there may be one gallon of sewage. It is quite clear in some cases that the nineteen gallons of clear water, even when combined with one gallon of sewage, are an actual improvement to the stream, and that if it were possible to keep out the effluent altogether the condition of the stream would be deteriorated. This is not a hypothetical case, but fairly represents existing circumstances. Under such a system as has been suggested it would be necessary for the effluents discharged into such a water-course to be a definite degree purer than the stream; then, when the authorities higher up had been brought into line and also turned out effluents of greater purity than the stream, the standard of purity would naturally raise itself by gradual steps. As the stream became less and less polluted it would be incumbent on every authority to gradually improve the quality of its effluent, until at length a uniform degree of excellence was obtained over the whole water-shed, perhaps not such a degree of purity as the law now demands—but does not get—but at all events one which would represent the highest practical limit for that particular district.

The Prevention of Strikes:

SATISFACTORY as the happy settlement of the Taff Vale Railway strike may be in itself, the circumstances are somewhat exceptional and do not justify the assumption that the day has at last dawned when industrial disputes will be adjusted in a reasonable and peaceable manner. For the highly satisfactory result which has been achieved in South Wales, we are almost entirely indebted to Sir William Thomas Lewis, and to the affectionate respect with which he is regarded by all classes in the locality. Consequently he has succeeded where the Board of Trade emissary failed. It would be ungracious, however, to overlook the just and temperate attitude adopted throughout the negotiations by Mr. Bell, the secretary to the Amalgamated Society of Railway Servants. He warned the men that they must in future desist from illegal action such as they had exhibited, he promptly rebuked those who were disposed to repudiate the settlement, and he lost no opportunity of explaining to his excitable followers that conciliation is always better than fighting. When we add that it was Mr. Bell who prevented the threatened strike on the Great Eastern Railway by persuading the men to give way on the subject of a conjoint deputation, we feel sure that our readers will join in our tribute of praise. If we dismiss from consideration the reprehensible practice of intimidation in the form of picketing, it must be admitted that the Society has acted in an entirely commendable manner.

South Wales will in future possess two conciliation boards, one which has been in satisfactory operation for twenty-five years in the mining industry, and the other, now to be formed, for the regulation of questions arising between railway companies and their men. There is no reason whatever why similar boards should not be constituted all over the United Kingdom for the amicable adjustment of differences between capital and labour. The problem is comparatively easy in the case of railway services, for the men are practically all in receipt of fixed weekly wages, their hours of work are known, and as a class they are men who perform their several duties cheerfully and conscientiously. Some of these men have to remain on duty for excessive periods at a stretch and the rate of pay is frequently low. On the other hand there are many advantages attaching to permanent employment on the staff of a railway company. As a rule the men are a fairly contented body, but at intervals they arrive at the conclusion that increased remuneration is necessary, or that the hours of labour are excessive. These are the only points which arise, and they can be, or ought to be very easily settled by a conciliation board. Miners are in a still more favourable position, for they work when they please and are paid according to the measured amount of work done. The only question which can possibly occur relates to the unit-rate payable. As this is now almost universally decided in accordance with the market value of the material mined, there is practically no chance of any dispute unless the men should make some new demand of a revolutionary character. At present, coal miners are almost in the position of lessees selling the mineral raised at a variable market rate.

When we come to consider relations between employers and men engaged in manufacturing concerns, difficulties are at once perceptible. The chief difficulties and stumbling-blocks are invented by the Trades Unions. Personally, we have no objection to these societies; we do not question their right to do all that is possible to improve the status of the mechanic and the working man. But we do condemn in the strongest possible terms the pernicious doctrines disseminated, and the colossal ignorance displayed by many Trades Union officials. By all means let the men unite; let them be paid ample wages according to the intrinsic value of the services rendered; let the man who can fairly earn two, three, or four pounds a week be entitled to earn it; but let the

lazy or bad workman receive no more than he is worth, or let him be turned away from the trade to which he is a disgrace. If the Trades Unions would take solemn warning by the examples we have already had of successful foreign competition within our borders, and in markets where we once reigned supreme, some beneficial change might be hopefully anticipated. If the Unions would but encourage technical knowledge, manual dexterity, and conscientious performance of duty, they would be undertaking an invaluable task ; one which would entitle them to the support and admiration of every true patriot, and which would be of distinct value to the working man. Our readers and the Union officials themselves know full well how little such objects as these are considered. There is a great gulf fixed between such associations as the Amalgamated Society of Railway Servants and the societies which live by pandering to the worst instincts of ignorant men. Until Trades Unions are reformed we fear the only remedy for strikes will be found in an offensive and defensive union of all employers, and in legislation giving the Trades Unions a legal status so that their accumulated funds may become available for the payment of damages for loss sustained in consequence of unjustifiable strikes or of other improper action. In its present condition the situation is decidedly interesting. The men have only lately realised, and are rejoicing in, their newly-developed strength. They have not yet learned discretion, and their advisers are not qualified by education or by worldly knowledge to offer wise counsel. On the other hand employers are somewhat slow in appreciating the altered position. Accustomed in the past to be masters, and as such to be regarded with a considerable amount of deference and to exercise almost unlimited control over their own affairs, they are now merely employers who are permitted entire liberty in financial matters and are expected to suffer all losses sustained, but the men claim to participate in the details of workshop management, and some of their more foolish leaders encourage the idea that the business concerns of the country should really belong to the men if everyone had his rights.

Certainly some discretion has been acquired in consequence of the great engineering strike, but the men have still a good deal to learn. Employers have also to realise the insecurity of their position under existing circumstances. In addition some method has to be devised for adjusting differences in an amicable manner and of placing the industrial organisation of the country upon a more sound and satisfactory basis. These matters are already engaging the attention of thoughtful people, but no one has yet brought forward a proposal as to the manner in which they may be most suitably dealt with. Our own view is that the complete organisation and federation of all employers should be no longer deferred. If this were accomplished, it would be comparatively easy to provide for the mutual discussion of various questions by periodical conferences of Employers' Associations and Trades Unions, and probably some practical measure might ultimately be formulated and submitted to Parliament, having for its object the settlement of all trade disputes without the necessity for strikes or lock-outs. Mutual intercourse of this kind would inevitably tend to promote a better understanding between employers and employed, and it might be made the means of teaching the men that their own interests and those of the country at large are not quite so divergent as they have been taught to believe.

British Trade with Russia.

It is estimated by competent authorities that the amount of capital invested in Russia by German joint-stock companies is four times as great as that laid out by Anglo-Russian companies, that Belgian company investments in Russia are five times as great as British, and French seven times as great. That Germany should do a large business in Russia, her next-door

neighbour, is only to be expected, and that our own trade with the Russ should not exceed that of an adjoining country is no matter for wonderment. But when we find that Belgium and France, whose manufacturers have no better geographical position in reference to Russia than those of Great Britain, are so far overleaping us, it is difficult to account for the discrepancy. Without attempting to enter into an elaborate analysis of the reasons why British enterprise in Russia has been so left in the rear, interesting as such an inquiry might be, there are certain features of the Russian trade and industrial development which may, with perhaps some advantage, be touched upon. To a large extent the lack of expansiveness on the part of the British capitalist and merchant, so far as the dominions of the Czar are concerned, may be traced to two causes—adverse sentiment, and the indifference born of prosperity.

Ever since the Crimean War, when, as Lord Salisbury jocularly observed, "we put our money on the wrong horse," the political relations between this country and Russia have always acted as a wet blanket upon British commercial enterprise in that country. There has been the feeling that, however fair the horizon in the East might appear, the thunderclouds of war might rapidly gather, that before the storm had spent itself anything might happen, and that the happenings might mean utter ruin to any British interests in Russia. Besides which the Government of Russia is looked at very much askance by Englishmen. Its despotic character is not only cordially disliked, but its methods distrusted. Also, British merchants have had other fish to fry. Admitting to the full the influence of these factors, there is yet another which has operated in the past, and will, it is to be feared, do so in the future—*i.e.* our ignorance of the Russians and all their works.

To begin with, it is necessary to reiterate that threadbare complaint against the British trader—his shortcomings as a linguist. The number of *bonâ fide* British merchants who have a thorough knowledge of the Russian tongue might almost be counted on the fingers of one hand. At present those of our traders and manufacturers who are represented in Russia have to rely for the most part on foreigners —usually German—for the pushing of their business. This is obviously not a healthy way of maintaining or extending a connection. And so long as this state of affairs lasts it is highly improbable that the British connection and influence in Russia will be much widened or deepened. The Germans, on the other hand, have not only established themselves firmly in the cities, but have placed themselves in direct communication with the country districts, and have assiduously cultivated trade relations with the village communities. There are peculiar reasons why this course has proved profitable to them.

When the Russian serfs were emancipated, it was inevitable that one phenomenon, at least, which has been conspicuous in other countries in cognate circumstances would be exhibited in Russia. The peasants, who had previously been almost as much part and parcel of the estates of the nobility as the cattle and sheep, had had no option but to remain in the township where they were born, except in special cases, where their masters thought fit to give them permission to depart. When the great change took place which gave the peasant liberty of movement there was a strong and immediate tendency for the rural population to flock into the towns. The Russian Government were fully alive to the economic and political danger of such a result. One of the measures taken to antidote the threatened congestion was the encouragement of co-operative industrial societies in the villages. It was a

wise and far-seeing policy which has borne good fruit. All over Russia in Europe there are, in the country districts, well-established and flourishing societies, whose organisation enables a large section of the peasants to utilise profitably their spare time, particularly in the winter. One result is that production in numerous cases has overtaken the local demand, and the goods have gradually found a market across the frontier. The Germans have successfully developed a very profitable trade with these village societies, not only supplying them with tools and machinery, but buying from them their finished products. These include an immense variety of articles, according to the district of their origin, but conspicuous amongst them is cabinet work of a high order. Also many small goods, which, in this country, have been regarded as peculiarly German, are now being made in these Russian co-operative workshops. So that the German merchant wins a double advantage.

This trade has been gradually and quietly worked up merely because the Germans took the trouble to acquaint themselves with the circumstances of the Russian people. The work has been done, as it usually is by the Teuton, thoroughly and systematically. It may, of course, be argued that it is the proximity of the two countries which has made such intimate and profitable relations possible. Actually this geographical advantage has been far less than it appears. Intercourse between the two peoples near the frontier, and the great number of Germans long established in Western Russia, would imply that early information of requirements and possibilities which were necessary to the initiation of this particular trade. But with the exception of those provinces lying contiguous to the German frontier, the cost of transit as between, say, London and the centre of Germany would as often as not be in favour of London. Besides which it may be confidently stated that, jealous as the Russians are of British expansion, the individual Englishman is, other things being equal, more popular in Russia than any other foreigner.

If, therefore, British commercial firms would take the trouble to be really well represented in the country, they would have quite as good an opportunity of extending their business as those of any other nationality. But the representative should be in every respect well-qualified. He should know the language well, he should be a good negotiator as well as a good salesman, and he should be capable of taking a certain social position. This latter point is often overlooked, although in Russia it is a matter of great importance. The Continental ambassadors of commerce who are sent to work up a Russian trade are usually gentlemen of culture, capable of holding their own in any society. And in no country is this of more importance to the business man than in Russia.

Beyond all this comes the question of how far British goods are well adapted for the Russian market. Speaking generally, the Continental productions at the present time are better fitted to the requirements of the people than are the British. To take a typical case: plough-shares are sent by the Germans into Russia of the shape and weight adapted to the Russian ploughs, the frame of which is wood and frequently home-made. English manufacturers of agricultural machinery have not condescended to attempt to cater for such a trade. But if the moujik gets into the habit of buying his plough-shares from a given firm, he will probably go to the same house for a harrow and a drill. It is the same all round in other kinds of machinery. As the Russian co-operative societies develop they will require more and more complex machinery, and their requirements in the future may be immense. As things are drifting at present, this trade is likely to remain in Continental and American hands. For those firms who can afford to lay out capital in extending their foreign trade, and who are not too much absorbed with other business, Russia offers a distinctly hopeful field. If English capitalists had the inclination they could do as well there as the French, the Belgians, and the Germans, and they would be just as cordially welcomed. In particular, there are many departments of the engineering trade where favourable openings might be found.

"We are, in the vastness of our possessions, losing our grip on national sentiment. It is our duty to maintain intact, and to defend by sea and land, all that our empire builders have left us. The day that sees the defence of the British Empire sapped, sees the disintegration of the Nation's trade and the hands of civilization's timepiece put back 200 years."—Rt. Hon. Lord Charles Beresford, C.B.

The Teaching of Mathematics . . .

Professor Perry's views on the subject of mathematics, and the manner in which this department of knowledge should be taught, seem likely to bear fruit in a practical manner, as since the deliverance and publication in condensed form of his celebrated lectures before working men at the Museum of Practical Geology, Jermyn Street, we notice that more than one technical school has included in its curriculum the method recommended by the professor, abandoning at the same time the orthodox system, which has proved a *bête-noir* to the majority of engineering students.

Whatever be the standpoint taken up by any critic of the practical method, it must be conceded that by its aid many students achieve in calculation results which for them would otherwise have been impossible.

It is a safe dictum, generally, that no knowledge is thorough or profound which does not start from first principles, enabling the student to grasp the reason why a thing should be so rather than otherwise. There are, however, exceptions to every rule, and in the case of practical mathematics we hold that the end, namely, to devise such a system of teaching as will enable a young applier of physics or an engineer to make his mathematical knowledge part of his mental machinery, which he shall use as readily and certainly as he does his legs, is amply justified, independent of all consideration as to the means.

These means it is the wish of the Science and Art Department of South Kensington to encourage, and last year was notorious by the fact that for the first time the subject of practical mathematics was introduced into the syllabus issued by the Department, and students in the subsequent examinations were allowed also for the first time to use squared paper in formulating their answers.

Most of our readers have learned to value this inexpensive commodity—before 1876 it was 8d. per sheet—at its proper worth, but it is open to doubt whether the whole of the engineering fraternity thoroughly realise what can be accomplished by it, and how problems can be solved by its use without having mastered the most elaborate algebraic and trigonometrical investigations.

Let us instance a few. The plotting of statistics of any kind whatsoever, the finding of intermediate probable values, probable errors of observation, the calculations of a table of logarithms, areas and volumes, plotting of functions, such as $y = ax^n$, $y = ae^{bx}$, where a, b, n may have all sorts of values, the solution of equations, speed of a body, determination of laws which exist between observed quantities, especially of linear laws, etc., etc.

We would advise those who would know more of this to write to the Science and Art Department for a copy of Professor Perry's lectures.

That Germany awakened some time back to the necessities of education reforms is a well-known fact. It is equally patent, says Professor Perry, "that the most prominent Englishmen understand nothing of those sciences which are transforming

all the conditions of civilisation. Just as a schoolboy is allowed now to perform arithmetical work which was quite beyond the Alexandrian philosophers, and no one dreams of philosophising over Euclid's 7th, 8th, 9th, and 10th books, so the other books must be superseded. For the whole of the 5th book of Euclid we need only half a page of easy algebra."

The professor's right in making this statement cannot be questioned, seeing that he has mixed for many years in educational and technical circles, and is therefore likely to appraise at its true value the methods commonly pursued in our schools and colleges. The demoralising effect upon the average boy of the academical course of mathematics has become a pleasantry, and yet, to what extent does civil, mechanical, and especially electrical, engineering, rely upon exact calculations! To again quote the professor, and in this opinion we can bear him out: "The average engineer in good practice would rather work a week at many separate arithmetical examples than try for an hour to get out the simple algebraic expressions which includes all his week's work and much more, yet he has passed perhaps certain rather advanced examinations in mathematics. Furthermore, those engineers who can most readily apply mathematics to engineering problems almost invariably descend to the position of teachers and professors in schools and colleges, and they seem to lose touch completely with the actual life of their profession."

In the case of workmen and operatives the difficulties in attracting them to evening classes in technical schools, and in retaining those who once make a start, is largely connected with the indispensable course of mathematics that is to be pursued, either in conjunction with, or preliminary to, the study of the more fascinating and practical portion of science subjects.

Taking into consideration the immediate practical application of rules and methods of computation in the various branches of mechanical and electrical engineering, physics, and chemistry, it was of paramount importance that a system of mathematics should have been devised which should make the path broad and easy for those students who have neither the inclination or opportunity—especially the former—of going through a complete and systematic course of pure mathematics, and who desire only such knowledge of the subject as will meet their practical needs.

In spite of the criticism that has been levelled at him by his more academic detractors, Professor Perry has, by his energy and zeal in the interests of average boys and men, by his outspoken criticism of methods of orthodox teaching, and, finally, the delivery and publication of his admirable lectures, rendered a real service to the cause of technical education in this country.

Acid-Blast Metal Etching . . .

A NOVEL system of etching metal plates has recently been brought into practical operation at Philadelphia, U.S.A. The method consists in the application of an atomised spray of acid, projected vertically upwards against the metal surface to be etched, by means of an air-blast apparatus. Air is supplied through a receiving tank at a pressure of from 5 lbs. to 8 lbs. per square inch from a Root's rotary air compressor. The apparatus consists essentially of an etching-case and a washing-case, fixed one in front of the other over the separate compartments of a shallow tank. Compressed air passes from the air-tank to the "atomisers" and to the washing apparatus through two pipes controlled by three-way cocks. These are disposed so that when the air current is in communication with the aspirators a supply of water is passing to a reservoir placed between the aspirators. A pipe from one of the three-way cocks carries air to a series of metal tubes placed below the bottom of the compartment, containing acid, and a large number of atomisers, branching from these tubes, project above the surface of the fluid. Each atomiser consists of a central tube, supplied with air under pressure, and surrounded by smaller tubes in communication with the acid in the tank. In virtue

of this arrangement the air-blast produces a finely divided spray of acid, which is projected with considerable force against the metal surface required to be etched. Surplus acid falls back to the lower part of the tank, when it is again drawn into the atomiser, and thus the liquid is continuously circulated during the progress of the operation. Two movable frames are fitted in slides attached to the sides of the case enclosing the atomisers, and reciprocating motion is communicated to the shelves by an arm actuated from the shaft of the air-compressor. In each frame is a sliding frame, which can be drawn out at the front of the etching box, and to the under-side of this frame is attached the plate to be treated. During the process of etching the motion of the movable frame serves to distribute the action of the blast equally over the plate, to intensify the action of the acid, and to facilitate the detachment of drops from the metal. As soon as the etching process is completed, the plate is slid, by means of the sliding frame, into the washing case, where it is thoroughly cleaned by water issuing under pressure from a series of perforated pipes.

Well authenticated experiments show that erosion under the acid blast is very rapid. Some zinc plates treated with nitric acid diluted to 10 degs. Beaumé, were etched in three minutes as deeply as the "second etch" of the immersion process, which would probably occupy about twenty minutes. It would be quite impracticable to force the speed of erosion with the bath in the ordinary process, as details would be eaten away by undercutting, and the heat generated would imperil the security of the resistant. In the case of the acid-blast process, the projection of spray upon the surface in a perpendicular direction ensures proper etching without undercutting the protected parts of the metal. Overheating is also successfully avoided, for as the compressed air is thoroughly cooled before it enters the aspirators, the amount of heat absorbed during expansion is fully equal to that due to chemical action between the acid and the metal.

The Central Canada Chamber of Mines . . .

LIKE many of our contemporaries, no doubt, we are in receipt of an enormous amount of printed literature, published under the sanction, it seems, of the "Central Canada Chamber of Mines," a new institution counting among its patrons, presidents, and vice-presidents, men whose names must go far with the general public to awaken confidence. After perusing, however, the contents of the printed slips called "press-cuttings," because they have been reproduced by one or two obscure local papers, we cannot help expressing our astonishment that such stuff, resembling in style and conception the worst specimens of Western American journalism intended to "boom" some shady enterprise, should find the endorsement of the gentlemen mentioned on the head of the notepaper upon which the invitation to reproduce these articles is written. The *Pall Mall Gazette* some time ago criticised this literature as "extravagant," and added that it is of the character generally heralding wildest companies' promotion. The authors of the booming articles are irritated at this and ask us to print the *Pall Mall Gazette* criticism and their reply. Quite aside from the fact that our Magazine has no space for propaganda of any kind, we cannot but agree with our London contemporary in the remark quoted, as well as in its just observation that the assertions contained in the Central Canada Chamber of Mines literature are "not supported by the evidence of any accredited mining experts who are known to British investors." Nor have we received, up to the present, any explanations inducing us to change our view, which is that, though we naturally hesitate to accuse the promoters of bad faith, they evidently are void of the commonest judgment, if they believe that literature of the kind they have been sending to Europe can have any other effect than that of awakening a very strong suspicion in the minds of the readers that if the gentlemen concerned do not lack honesty they, at all events, lack good taste.

Pipe-Laying in Deep Water . . .

IN connection with the metropolitan sewerage system of Boston, U.S.A., some distinctly novel methods of procedure were necessitated.

At one point, the North Metropolitan main sewer crosses a channel in Boston harbour known as Shirley Gut. The waterway is here 315 ft. wide at mean high water, with a depth of 25 ft. in the middle. The tidal current is always running, and it is so swift that the building of a temporary timber bulkhead was necessary before work on the inverted siphon could be commenced. A trench was dredged for reception of the pipe, which was built on shore in six separate sections of riveted tank steel, $\frac{3}{8}$ in. thick, 8 ft. 5 in. in diameter, with a total length of 264 ft. Each section was lined with three rings of brickwork in Portland cement, leaving the internal diameter 6 ft. 2 in. Two of these sections were short pieces furnished with manholes; the others varied in length from 48 to 68 ft., and weighed from 80 to 112 tons each. They were curved so as to form a depression of 22 ft. in the axial line of the completed work. Strong timber bulkheads, furnished with valves, were fitted to close the ends of the separate sections, which were floated at high water alongside of scows provided with hoisting gear. The sections of pipe were then partially filled with water and lowered singly into their appointed places in the trench, where they were afterwards bolted together by divers. When the bulkheads had been removed, water was pumped out through the manhole sections, so that the connecting rings of brick masonry could be built up inside. Finally the interior was smoothly lined with Portland cement rammed into place.

Beyond Shirley Gut the sewer passes the pumping station on Deer Island, and the outlet is continued a distance of 1860 ft. into the sea. Of this some 674 ft. was constructed by excavation within a cofferdam, and the remainder by a modification of the system adopted at Shirley Gut, built-up timber lagging being used instead of steel shells for the pipe sections.

At this part of the work the separate sections were each about 52 ft. long, but instead of being built upon the beach, they were constructed on specially designed cradles at each side of a pier erected by the Commissioners. The cradles were suspended from a system of gearing capable of raising or lowering the cradle and sewer section uniformly throughout. After the cradle had been lowered into the water, the pipe-section was floated out and towed by a steam tug to its assigned position over a dredged trench, where it was fixed in a manner similar to that previously described, and a filling of gravel over the whole length completed the work.

The North Metropolitan Sewerage System drains a very considerable tract of country, and by taking the outfall to a point where the discharge is speedily dispersed into the open sea, the Boston Commissioners have set an example which might advantageously be imitated in this country, and notably in connection with any extensions of the main drainage system of London.

The Penalty of Carelessness . . .

THERE is one factor of considerable importance, and having a direct bearing on the question of competition, on which, we believe, not sufficient stress is being laid in the editorial comments on the subject, namely, the fact that wherever and whenever our commercial and industrial rivals have succeeded in obtaining a victory over us, this has been due, not to our inability, but, almost without exception, to avoidable causes and to our being remiss in our duties. Indifference, superciliousness, stubborn adherence to obsolete methods, foolish disinclination to learn from others—these and similar characteristics explain why we have been losing ground in recent times. In other words, we have been losing it entirely through our own fault, and not because we suffer from conditions over which we have no control. It is painful, therefore, to learn that to the above-named sins of omission another one has to be added, namely, that of carelessness, and the more painful, as

conscientiousness and thoroughness has so long been acknowledged throughout the world as a national characteristic of our race. This charge of carelessness comes from one of our own representatives abroad, *i.e.*, from the British Consul at Madeira, who last year directed the attention of the Foreign Office to the fact that goods were handled with greater care on German than on British vessels, and that this, no doubt, was an important factor in the rapid progress of the German carrying trade. This hint, one would imagine, should have sufficed, but that such has not been the case is evident from another report quite recently received from the same gentleman, in which he states that during the past year he has received further statements on this subject from local merchants, who bitterly complain of the condition of their goods on arrival in British ships. This is a state of affairs deeply to be regretted, for if our shipping trade once obtains a bad name, it will require much trouble and labour to rehabilitate it in the eyes of our customers, for it is infinitely more difficult to regain a reputation that has been lost, than to maintain it when once it has been established. We often hear the remark that, though our competitors may have beaten us in one or two directions, the damage does not amount to much, and we can easily "pick up" again. This is a serious error. That we can easily maintain the high position which we still hold in most branches of commerce and industry there is not the slightest doubt, but "picking up" again is a far more difficult task than is usually realised. The fact which is often lost sight of is that the ground we lose does not remain vacant, but is almost immediately occupied by others, owing to the arduous struggle for supremacy in modern times, and to dislodge the newcomers requires ten times the energy that would have sufficed to keep them away. Those, therefore, who neglect to safeguard the splendid inheritance from our ancestors, who handed over to us a reputation by which Great Britain was universally acknowledged as the greatest industrial country in the universe, leave to their descendants a task for which they will not thank them.

The Antiquity of Tools . . .

THERE was a time, not so very long ago, when it was generally believed that the gigantic buildings and stone structures of prehistoric times, and even many of the great monuments of the most remote historical times, were erected in some mysterious way, totally differing from modern methods, since but few tools had been discovered, and no record had been left of the *modus operandi*. It is strange, however, that there is such a reluctance on the part of our contemporaries to admit the much more natural explanation that, even though proofs were wanting, the same results at all times are obtained by the same or similar means. However much people now-a-days may feel inclined to grant that the ancients had reached high stages of civilisation—much higher even than our own in one or the other regard, as, for instance, the plastic art, philosophy, government, etc.—it is odd that not one in a hundred will readily agree that there ever has been a race equal to ourselves in scientific knowledge and the practical application of science. Gradually, however, the truth is gaining the upper hand, and we learn that the men of the past availed themselves of instruments very much resembling our own in performing the work that we perform, and consequently there results the corollary that when they excelled our work, most likely their method and means excelled our own. It is only quite recently that the discovery has been made that the ancient Egyptians used for their stone-cutting circular saws set with diamonds, a kind of saw that even in modern times has not been manufactured in a satisfactory way, owing to the difficulty of fastening the diamonds so firmly as to prevent their flying off when the saw is working, and it would not be astonishing at all to learn in the near future, that the tools with which the ancient Egyptians or Assyrians built their gigantic masonry structures were superior to those that we possess. A great deal has been discovered of late by archæologists to confirm this view, and nobody perhaps deserves greater credit for

causing a change of opinion among us than Dr. W. M. Flinders Petrie, D.C.L., of University College, London, who has recently returned from Egypt, and whose successful excavations in that country are described in a lecture to the Royal Artillery Institution, which is printed in its Proceedings. Amongst many other highly interesting objects he found at Thebes instruments dating from the time of the Assyrian invasion of Egypt, *i.e.*, about 670 B.C., being probably the stock of an Assyrian armourer, and made of iron worked in the highlands of Assyria. They include a chisel very well formed, with a wood stop upon it to prevent it from being driven into the handle; a file somewhat resembling a very thick knife, but with the whole surface scratched across like a saw file; a scoop bit for scooping its way into wood; a rasp exactly like a modern rasp, with teeth punched up all over the face of it; a small chisel of the mortice chisel form, very deep, with a ferrule and a little pointed tool for punching; three saws, with the teeth pointing rather towards the handle, showing that it was a tool for pulling and not for pushing, but otherwise not unlike our modern saws, and various other implements which any modern workman would be quite ready to use. Dr. Petrie, moreover, found a great number of products of manual skill which show a high development of technical knowledge, and anyone reading his very interesting lecture will come to the conclusion that, even as regards applied science and technical skill, there is probably nothing new under the sun, and that even in remote historical times much of our nineteenth century work has been equalled if not surpassed. Nor is it unreasonable to suppose that this great scientific age may have had one or more prototypes of which not even a trace has been left, since those who witnessed it were swept out of existence by some catastrophe that changed our globe so as to destroy man's work entirely, and to leave virgin ground for a new development from barbarism toward civilisation.

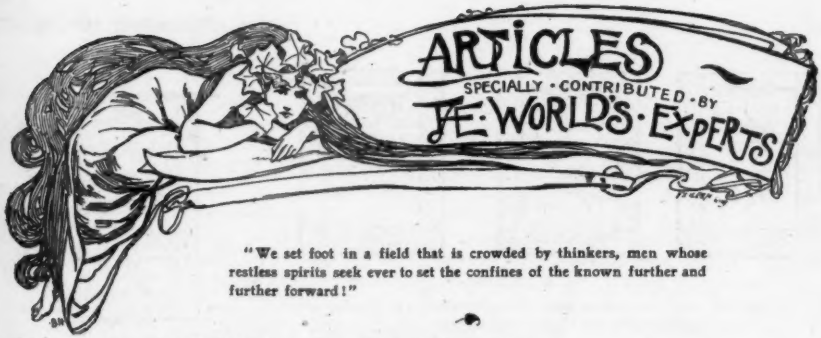
Manchester Ship Canal . . .

ALTHOUGH the sanguine hopes which were entertained by the original promoters of this undertaking have not been realised, there are unmistakable indications that its complete financial success will ultimately be established. Even at the present time it is fully admitted that the canal is a remunerative concern to the community if not to individual investors. Notwithstanding the decrease of shipments from the district, the traffic on the Ship Canal has exhibited a considerable expansion during the past half-year. Owing to the Indian famine and the unhappy state of things in China, there have been experienced a scarcity of cotton, a diminution in the export of Manchester goods, and a general depression in the carrying trade. Nevertheless, the fact remains that the quantity of merchandise passing through the port was greater by 230,000 tons than in the corresponding period of the previous year, and the receipts showed a net increase of £17,163. It does not appear that the prospects for the half-year now running are particularly hopeful, but on January 1, 1901, some important changes will take effect. Manchester will no longer be a free port for ships, and shipowners will be asked to pay dues, as elsewhere. Rent is also to be charged for berths and sheds appropriated, and a reasonable charge will be made for tonnage. Although no additions to the tolls are contemplated in respect of merchandise, notice is to be given that penalty charges and regulations will be enforced in order to ensure the more rapid removal of cargo from the quays. No one can reasonably find fault with this policy, as it is only natural that the laxity permitted when the company had to attract customers by every possible means cannot be continued now that the dock accommodation is more fully, and in some departments too fully, occupied. In the opinion of the chairman, a continued increase of traffic, if not any sensational development, may confidently be expected. We made reference recently to the considerable extensions of the dock establishment now in progress, and which cannot fail to be productive of satisfactory results.

SUP

850 H.P. "WESTINGHOUSE" INDUCTION MOTOR
OPERATING THE MOVING PLATFORM AND ELECTRIC RAILWAY AT THE PARIS EXHIBITION.

For Description see page 457.



"We set foot in a field that is crowded by thinkers, men whose restless spirits seek ever to set the confines of the known further and further forward!"

Electrical Methods of Heating as Applied to the Working of Metals.

By G. W. De TUNZELMANN, M.Inst.E.E.

THE Author of the following article matriculated at London University, and entered University College, London, in 1873.

From 1876 to 1878 he acted as Dr. Henrice's assistant in mathematics. In 1877 he was elected a member of the London Mathematical Society, and of the London Physical Society; in 1890 he became a member of the Institution of Electrical Engineers, and he is a member of the Société Internationale des Electricians, and of the Berlin Electro-Technical Society.

In 1881 he was asked by Professor Foster to undertake some experimental work he had in hand for the British Association, *i.e.*, testing a method devised by him for obtaining the value of the ohm. The results are embodied in the British Association "Report" during 1881. In 1882 he was appointed Assistant Examiner in Magnetism and Electricity to the Science and Art Department, South Kensington, an appointment which he resigned in 1896.

In 1889 he founded the Electrical and General Engineering College at Earl's Court, and in 1895 started, in connection with the college, the Electrical and General Experimental Engineering Works, for the development of new inventions and the construction of machinery and apparatus for experimental and other purposes. In 1895 he also became Managing Director of the Alternate-Current Electromotor Syndicate, and on the formation in 1896 of the Davies' Motor Company retained a seat on the Board, but resigned at the end of 1897. In 1897 he became Consulting Engineer to the Electric Metal-Working Syndicate. He has contributed largely to the scientific journals.

Mr. de Tunzelmann is the author of "Electricity in Modern Life," one of the volumes of the "Contemporary Science" series.

THE first application of electrically generated heat to the working of metals, was, as far as the writer's knowledge extends, made by Sir C. William Siemens in the early eighties, very shortly, in fact, after the commercial introduction of the electric arc for lighting purposes. It consisted of an electric furnace constructed for laboratory experiments involving the fusion of highly refractory metals and ores.

The furnace was formed simply of a

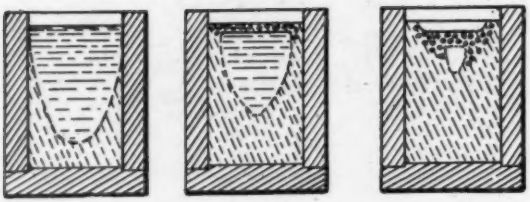


FIG 1. FIG. 2. FIG. 3.

ILLUSTRATIONS SHOWING THE MANNER IN WHICH FLAWS ARE FORMED IN THE ORDINARY METHOD OF CASTING.

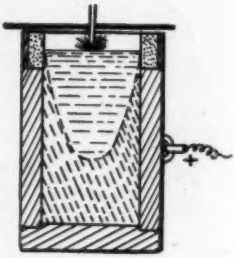


FIG. 6.

ILLUSTRATION SHOWING SLAVIANOFF'S METHOD OF AVOIDING FLAWS IN CASTINGS BY ELECTRICALLY MAINTAINING THE UPPER PORTION OF THE CASTING IN A FLUID CONDITION UNTIL THE LOWER PORTION HAS SOLIDIFIED.

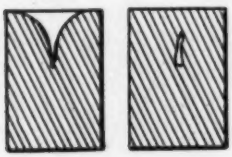


FIG. 4. FIG. 5.

ILLUSTRATIONS SHOWING THE RESULT OF SHRINKAGE IN CASTINGS, WHEN BUBBLES ARE ELIMINATED BY ALLOYING THE METAL, AND BY CASTING UNDER PRESSURE RESPECTIVELY.

plumbago crucible in connection with one of the leads of a dynamo, usually the positive one, the other lead being connected to a carbon rod held centrally within the crucible. The method of using the furnace consisted merely in striking an arc between the carbon rod and the crucible, and then injecting the metal or ore to be fused into the arc which was maintained as the fused material accumulated between the carbon rod and the fused contents of the crucible.

Electric furnaces developed from this simple form are now in use on a very large scale for the reduction of aluminium from its ore and for the manufacture of carbide of calcium, carborundum, and many other chemical products, but these do not come within the scope of the present article, which is limited to the consideration of applications of electric heating to the working of metals.

One important modification, however, of the electric furnace, which has recently been made by Mr. B. H. Thwaite, demands notice here, and this is the device of surrounding the central carbon electrode with a tube of some non-conducting and highly refractory material, and by means of this tube introducing some reducing gas, such as coal-gas for example, to enable iron and steel to be fused without oxidisation. While the fusion is taking place the temperature of the crucible is maintained as high as possible by means of a gas flame, and by this simple means castings of steel, iron, and other metals can be made wherever electric power is available without requiring the construction of a bulky and expensive crucible furnace. The writer is at the present time engaged in conjunction with Mr. Thwaite in carrying out a series of experiments with this furnace and perfecting certain details which he anticipates will make it possible to obtain castings of true malleable iron, and moreover to do this without the tedious process of annealing now requisite for the production of what are mis-called malleable iron castings.

The French Engineer, M. de Meritens, modified Sir William Siemens' process by replacing the crucible by the metal itself, an arc being struck between the part of the metal requiring to be melted and a carbon electrode. This process was further developed and improved, in the first place, by M. Benardos, a Russian engineer, and

subsequently by Messrs. Lloyd & Lloyd, the well-known tube-makers of Birmingham, who purchased the British rights in the Benardos patents. This process has been commercially used to a considerable extent, and will therefore be presently considered in some detail.

The chief drawback to the Benardos process is the impossibility of varying the intensity of the heat to be applied to the portion of metal under treatment, and various persons have therefore attempted to employ an arc struck between a pair of carbons. The writer is informed that this was done a good many years ago at Messrs. Siemens Bros.' works, and more recently a German engineer, Herr Albert Hirsch, has successfully used an apparatus of this kind in his works, both for filling up blowholes in castings and for welding up the joints of iron tubes.

Werdermann, Zerener, and others have used a similar arrangement, with the addition of either a permanent steel magnet or an electro-magnet connected up in series with the arc, and by means of which the arc may be directed with considerable accuracy upon the particular place where the heat is required. Others have used an air-blast for the same purpose.

Apparatus of this kind, either with or without electro-magnets, has been employed for brazing and soldering as well as for the purposes previously mentioned.

The directing magnet would be a desirable addition for many kinds of work, but the great practical difficulty in its use is that, unless the magnet is made so large and heavy as to make the apparatus extremely cumbrous and clumsy to use, it has to be placed so near to the apparatus that the permanent magnet would lose its magnetism, or the coils of the electro-magnet would soon get damaged.

The great drawback, however, to all the earlier attempts to use the arc struck between two carbons in this way was that with ordinary carbon electrodes a considerable quantity of carbon in the form of solid particles is deposited in the work. In the case of fusing iron and steel this changes the character of the metal considerably, making it so hard that it is impossible to machine it afterwards, while in brazing and soldering it is difficult, and in some kinds of joints impossible, to get a clean joint owing to the deposition of carbon in the form of soot.

Some few years ago the writer made some experiments with one of Hirsch's tools, and after devising more convenient forms of apparatus for holding the carbons, he was confronted with this difficulty. It was obvious that the free carbon might be eliminated by the introduction of sufficient oxygen into the arc to produce complete combustion of the carbon, and he attempted to do this in the first place by means of an air blast, but though some fairly good results were obtained, the apparatus was difficult to manipulate. He then tried the effect of injecting oxides of metals, such as iron or manganese, which are reduced to the metallic form in the arc by giving up their oxygen to combine with the free carbon, and here again some fairly good results were obtained, but it was difficult to carry out the process with any certainty. He therefore determined to employ electrodes, in which the metallic oxide was incorporated with the carbon before it was moulded into rods and baked, and the apparatus in conjunction with these electrodes is now in commercial use under the name of "The Voltex Process" for welding, brazing, and filling up holes in castings by electro-fusion.

Electro-fusion has also been applied by M. Slavianoff, a Russian engineer, to maintaining the upper part of a casting hot until the lower portion has begun to solidify, so as to facilitate the escape of occluded gases and the rising to the surface of any pieces of slag or ash which may have found their way into the interior of the fluid metal while pouring, and would cause faults if not got rid of. The courtesy of M. K. Shafalovitch, another Russian engineer, who has kindly sent me some of M. Slavianoff's papers, enables me to give the readers of FEILDEN'S MAGAZINE some details of this process, which were communicated to the Imperial Russian Technical Society in 1895.

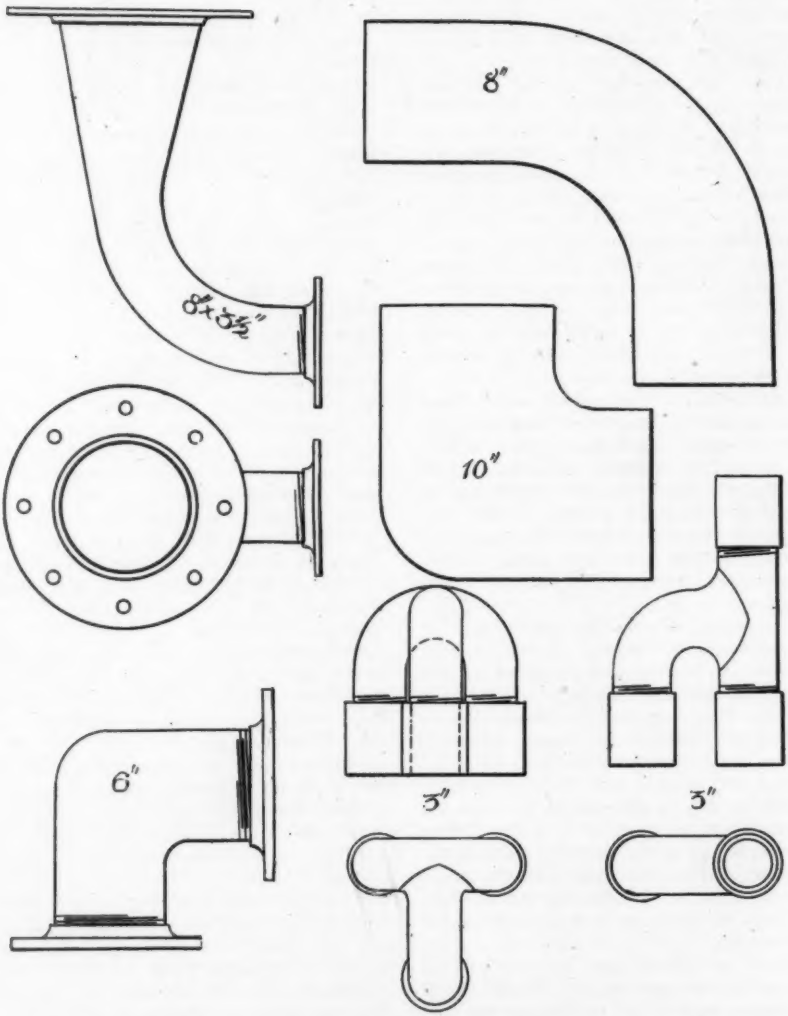


FIG 7.—TUBE JOINTS MADE BY MESSRS LLOYD AND LLOYD LTD., BY THE BENARDOS ELECTRIC WELDING PROCESS.

M. Slavianoff points out that the three principal causes of faults in castings are shrinkage, the presence of pieces of slag, and bubbles of gas occluded in the molten metal.

As the metal cools it shrinks in volume, and as cooling ordinarily takes place from outside inwards, vacuous spaces must make their appearance in the last portions to solidify, that is to say, in the upper half of the casting and especially about its central vertical axis. Faults due to slag, are, as he points out, generally caused by pouring at too low a temperature, and thus making the metal too viscous to allow the pieces of slag to rise to the surface through their lower density, as they would do if the metal were sufficiently fluid.

"Obviously," says M. Slavianoff, "it is of great importance that the metal after casting should be quite sound and homogeneous. Up to the present time the following processes have been applied for removing, or, at least, for lessening the above-mentioned evils.

"The first process is as follows. On the top of the mould, over the pouring gates, a cylindrical or conical vessel is placed. Then, above the metal in the mould there will be a certain surplus of metal which will have a higher temperature, and this, if present in sufficient quantity, will cool down later than the casting, and hence will fill the cavities, and, to a certain extent, reduce the volume of the gas bubbles. This method works well, but, on account of the great amount of metal which has to be wasted, is costly.

"In the second method the metal can be made more sound by chemical means. Certain alloys are added to the metal to be cast, and these alloys, acting on the liberated gases, give solid bodies as a result of chemical reaction, and hence, obviously, the bubbles do not form. But this process is not a perfectly satisfactory

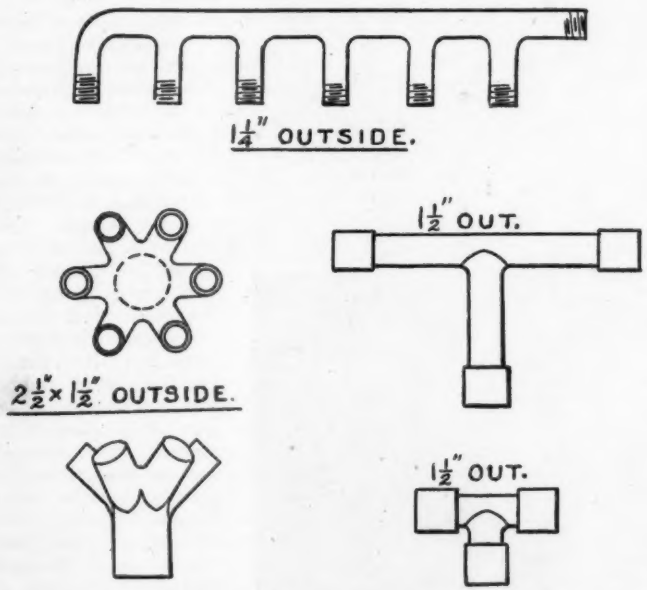


FIG. 8.—TUBE JOINTS MADE BY MESSRS. LLOYD AND LLOYD, LTD., BY THE BENARDOS ELECTRIC WELDING PROCESS.

one. In the first place, it does not prevent the formation of the shrinkage cavities, which do not result from chemical reactions, and in the second place the metal is deteriorated.

"Although neither of these methods, taken separately, is quite satisfactory, taken together they supplement each other, the first method abolishing the shrinkage cavities and the second one the gas bubbles. Both these methods are often applied together, especially for figure-casting, or casting of things which are not wrought afterwards; but for casting more or less large blocks of steel which have to be wrought, these methods, even when applied together, are unsatisfactory from an economical point of view.

"Let the steel be supposed to be cast in a cast-iron crucible (Fig. 1) with thick walls, and let us watch the cooling of the metal. From the action of the bottom and walls of the crucible the cooling begins while casting is still going on, and towards the end of the casting the section of the solidified metal will have the form indicated in the diagram (Fig. 1) by the dotted area. After a short time a thin crust of solid metal will be formed (Fig. 2) on the upper surface of the ingot, which will now represent a closed vessel filled with fluid metal. From this point the cooling will, obviously, take place in the direction from the outside inwards, and the gases as they are liberated in the form of bubbles will lift, or even tear through the crust while it is sufficiently thin; but as the crust thickens the gases will not be able to tear through it, and hence the bubbles will accumulate under the crust. Owing to the reduction of volume of the metal when cooling the upper crust, while it is not very thick, will be curved inwards and will form a so-called "shrinkage funnel" (Fig. 3). When the whole outside crust of the block has got sufficiently thick it will no longer follow the contracting liquid by bending inwards, and at this stage the shrinkage cavities will begin to form, and finally, the ingot will get quite solid and will take the form of Fig. 4. The upper part of the steel block, which contains the shrinkage cavities and gas bubbles, is superfluous, and is usually cut off and thrown away. The volume of this part is about one-third of the volume of the whole block, and the hotter the steel the larger is this waste portion. Imagine now that some reagent, such as aluminium, is added to the fluid steel with the view of improving the soundness of the casting. The cooling will be of exactly the same nature but without liberation of gases, and therefore the solid ingot will be without bubbles; the shrinkage will be of greater volume, and the section of the block will have the form of Fig. 4.

FIG. 9.—REPAIRING A SMALL STEEL CASTING BY THE VOLTEX ELECTRIC WELDING PROCESS.

"There is still a third method of obtaining a sound casting

which may be termed the 'mechanical or compressive method,' which is applied exclusively when casting steel blocks. The metal is cast in a very thick-walled mould, and while still liquid is subjected to strong compression by means of a powerful press. It has been found in practice that in this case the steel comes out without any gas bubbles. But owing to the great expense inherent to this method, it is hardly practicable, the press alone costing many thousand pounds, and even then only comparatively small castings can be obtained. Moreover, the shrinkage cavities still remain, having the modified form shown in Fig. 5.

FIG. 10.—REPAIRING A LARGER CASTING BY THE VOLTEX ELECTRIC WELDING PROCESS.

"From all this it is clear that the only cause of cast steel being unsound is the premature cooling of the upper surface of the block, and hence, that any method which will keep the upper surface of the casting in a fluid state whilst the lower portion is solidifying must produce sound castings free from both vacuous cavities and gas bubbles, the former being under these conditions obviously incapable of formation, the latter escaping freely as fast as they are formed. There are several ways of doing this, the best being the application of electricity.

"For this purpose the liquid metal surface is made to form the positive pole of an electric arc, of which a steel or carbon rod (Fig. 6) forms the negative pole. A mechanism (not shown in the figure) is provided to raise and lower the rod forming the negative pole, so that the arc can be formed in the usual manner, and by moving the lid shown in the illustration the arc can be moved about over the surface of the fluid metal. The object of this cover or lid is simply to prevent loss of heat by radiation. The thick iron walls of the mould have a thin metal prolongation lined with fire-brick or similar resisting material; the fused metal does not stick to this, and the fire-brick being an insulating material, no arc will be formed between the rod and the sides, and hence the latter will not be destroyed as might happen if no fire-brick were interposed.

"Experiments have been made which have shown that for the treatment of three blocks of crucible steel, each weighing about 6 tons, and one block of Marten's steel of about 14 tons, a continuous current of 800 amp. at 60 to 70 volts was necessary.

"Calculations as to the cost of production of steel by the above method show that Marten's steel costs 10 per cent. less, and crucible steel 22 per cent. less than when made in the ordinary way."

Another process which originated in Belgium consists in passing a continuous current through a lead-lined tank containing water made conducting by the addition of acid or of some salt, connecting the tank with the positive lead and the bar of iron to be heated with the negative lead, and plunging it into the tank. Owing to the high resistance of

FIG. 11.—APPLICATION OF THE VOLTEX ELECTRIC BRAZING PROCESS TO MAKING BICYCLE JOINTS.

the film of hydrogen formed around the submerged portion a large amount of heat is generated, with the result of rapidly raising it to a white heat, when it can be removed and hammered on an anvil, or welded in the ordinary manner to another bar similarly heated.

The heated metal is found to be quite clean and free from oxide on account of the reducing atmosphere of hydrogen with which it is surrounded.

It is, however, found to be extremely difficult to control the temperature, and therefore such utility as the process may possess is confined to easily weldable iron and mild steel, and also to pieces of simple form. High carbon steel is found to be burned.

Similar results may be obtained by replacing the acidulated water by charcoal powder, graphite, metallic oxides in a state of powder, or melted metal, heat being generated at the surface separating the bar from these substances owing to the resistance being greatest over his surface.

The next step was to do away with the liquid or powder and to connect two bars, to be welded end on, with the two leads of a circuit carrying a large current of low voltage. Owing to the comparatively high resistance of the joint it was found that the adjacent portions of the bars could be raised to welding heat, and not only iron but almost any metals when thus heated could be welded by simply pressing them together until a bulge was formed at the joint, and at the same time turning the bars round and hammering the bulged portion all round in order to consolidate the weld. This step was made by the American electrician, Elihu Thomson, and the process, which has been extensively used in the United States and to a lesser extent over here, is known as the Thomson process.

Besides the Slavianoff process which is in use at the Perm Gunworks and other places in Russia, and Mr. Thwaites' process of electro-fusion — of which I hope to say more a little later on, as it is now being experimentally developed— there are three processes which are now in commercial use, and which it will be of interest to describe in detail, viz. :—

(1.) The Benardos process of electro-fusion.

(2.) The Voltex process of electro-fusion, welding, brazing, etc.

(3.) The Thomson process of electric welding.

I prefer to consider them in this order, which is more convenient for the purposes of comparison than in the order of chronological development, which would place the Thomson process between the other two, which are both processes in which

FIG. 12.—DRIVING PINION OF A STEEL ROLLING-MILL, WEIGHING BETWEEN SEVEN AND EIGHT TONS, IN WHICH TWO BROKEN TEETH HAVE BEEN RENEWED BY THE VOLTEX ELECTRIC WELDING PROCESS.

the electric arc is employed, while the Thomson process is not.

THE BENARDOS PROCESS OF ELECTRO-FUSION.

In the Benardos system of electro-fusion, as previously stated, one lead is connected to the metal to be operated on, and the other to a carbon electrode, an arc being struck between the carbon and the metal, causing the latter to fuse.

The holder consists merely of a metal rod, terminating at one end in a wooden handle similar to that of a file or chisel, and at the other in a clamp, which can be made to hold the carbon in a position at right angles to the rod. A tin or iron disc is fixed concentrically to the iron rod in order to shield the workman's hand from the intense heat radiated from the arc.

The current, which varies from about 15 amp., for lead burning, up to about 300 amp. for heavy steel and iron work, is supplied in Messrs. Lloyd & Lloyd's works at Birmingham at 150 volts, and is cut down by regulating resistances to about 70 volts, so that the power employed ranges from $2\frac{1}{4}$ to 45 Board of Trade units per hour, or approximately from 3 h.p. to 60 h.p. The current may be supplied directly from a dynamo, as is done at Messrs. Spencer's steel works at Newburn, or from a dynamo connected up in parallel with a battery of accumulators, which is the method adopted by Messrs. Lloyd & Lloyd. Where there is a sufficient amount of work done to warrant the installation of a large battery of accumulators the latter method is preferable, as the dynamo can be kept running up to nearly its full output, the dynamo charging

FIG. 13.—DRIVING CLUTCH OF A ROLLING-MILL, PARTIALLY REPAIRED, SHOWING ONE LUG IN ITS WORN CONDITION AND THE OTHER RENEWED BY THE VOLTEX ELECTRIC WELDING PROCESS.

FIG. 14.—SMALL ROLLING-MILL PINION IN WHICH FOR THE PURPOSE OF ILLUSTRATION TWO WORN TEETH HAVE BEEN PLANED OFF AND BUILT ON AGAIN BY THE VOLTEX ELECTRIC WELDING PROCESS.

the accumulators when the amount of power taken is small and the two together supplying power when a sufficient number of arcs are in use at the same time.

The process is used in many steel works for filling up blowholes in castings, such as locomotive wheels, for example, several arcs being kept continuously at work for this purpose alone at the Newburn Steel Works.

As soon as the arc is struck the metal begins to melt at that point, and if it is a hole to be filled up this is done by introducing small pieces of steel one at a time and melting them into position. From time to time as the work proceeds the hot metal is hammered, which toughens and consolidates the melted steel instead of leaving it in a crystalline condition. The workmen's faces and eyes have to be protected by means of masks or helmets, with eye-holes covered with coloured or neutral tinted glasses which must be so dark that nothing can be seen through them before the arc is struck.

Messrs. Lloyd & Lloyd use the process to a very large extent for making tube fittings, examples of which, taken from drawings kindly supplied by them, are shown in Figures 7 and 8.

In making a joint of this kind a V-shaped groove is left between the two pieces to be joined, and this is then filled up by melting in small pieces of metal, and then hammering the weld as previously described. In lead burning, which can be carried out by this process without previously cleaning the surface of the lead, the carbon forms the positive pole and the work the negative one, presumably because when used in this way the heat to which the work is subjected is not quite so intense.

In treating wrought-iron and steel the carbon sometimes forms the negative pole, and sometimes the positive one, according to the nature of the work, and Messrs. Lloyd & Lloyd state that considerable knowledge and skill are required in order to make the proper choice. As it is the positive pole which chiefly volatilises, this arrangement causes the production of a large amount of iron vapour in the arc, which by increasing its conductivity, enables it to be drawn out to as much as 6 ins., which is a very important point, as the longer the arc the more uniform is the heating effect.

As far as the writer has been able to ascertain by inquiries of firms using the process, it is not suitable for cast-iron, the intense heat appearing to volatilise the iron and leave mainly the carbon behind. He has, however, been informed by Messrs. Lloyd & Lloyd that this is due to unskilful handling, and is very probably owing to too short an arc being employed. They state, as an example of work done in repairing cast-iron, that a very heavy cast fly wheel in their own works was broken into several pieces some five or six years ago, and repaired, with a view merely to its being used temporarily until a new one had been made. The work, however, turned out so well that the old wheel has never been replaced and is still running.

THE VOLTEX PROCESS OF ELECTRO-FUSION, WELDING, BRAZING, AND SOLDERING.

In the voltex process the arc is formed between a pair of electrodes placed nearly at right angles to each other and consisting of carbon mixed with a small percentage of oxide of iron or some other metallic oxide reducible by carbon at the temperature of the electric arc.

The current employed when continuous varies from about 10 amp. at 45 volts for soldering and small brazing work up to 400 or 500 amp., at 55 to 60 volts for heavy iron and steel work. That is to say the power required varies from half a Board of Trade unit to 30 units per hour, or approximately from $\frac{3}{4}$ of a h.p. up to about 37 h.p. When alternate currents are employed the volts are somewhat lower, and the ampères correspondingly higher.

In the latter case the current may be supplied direct from the dynamo, or through a transformer, and when continuous currents are employed, the supply, as in the case of the Benardos process, may either be from a dynamo directly or from a dynamo and battery of accumulators in parallel.

The effect of placing the electrodes at right angles to each other is that the magnetic action of the current passing through them blows the arc out into a long flame, the length of the arc being greatly increased by the presence of iron vapour produced by the volatilisation of the oxide of iron in the electrodes.

If the angle between the carbons is increased beyond a right angle this directive action is diminished. If, on the other hand, the angle is lessened, the effect is

FIG. 15.—VOLTEX ELECTRIC WELDING APPARATUS IN USE IN MESSRS. SIEMENS BROS. ELECTRIC CABLE WORKS AT WOOLWICH. THE WORKMAN IS SEEN READY TO BEGIN.

FIG. 16.—VOLTEX ELECTRIC WELDING APPARATUS IN USE IN MESSRS. SIEMENS BROS. ELECTRIC CABLE WORKS AT WOOLWICH. THE WORKMAN IS SEEN HEATING THE JOINT OF TWO LENGTHS OF STEEL ARMOUR STRIP.

increased; but if much less than a right angle it is found necessary to insert a wedge or plate of some highly infusible substance between the carbons close up to the arc, as otherwise the arc is formed partly between the sides of the carbons instead of being projected on to the work, which results in a considerable proportion of the heat being wasted. The heat is diffused over a larger area than in the Benardos process and is more under control, as it can be varied to any extent desired by varying the distance of the tool from the work, the apparatus forming a true electric blow-pipe. More homogeneous welds can thus be obtained, and the metal can be kept softer, enabling it to be more easily machined. On the other hand, this diffusion of the heat over a wider area makes the process a less rapid one than the Benardos. The workmen's faces and eyes are protected by means of masks, as in the Benardos process; and when using the larger tools, they usually wear asbestos aprons and sleeves, to obviate any risk which there might otherwise be of setting their clothes on fire.

In Fig. 9 a workman is shown repairing a defect in a small steel casting by means of a medium-sized tool; in Fig. 10 two workmen are seen repairing a larger iron casting, by means of one of the heavier tools, while in Fig. 11 a workman is seen using a small-sized tool for brazing up a bicycle frame. These three photographs were kindly taken for me by my friend and colleague, Mr. John Horace Reeves, who is a skilled amateur photographer. They were taken on the premises of the General Engineering Company, Limited, which is handling the process in this country. Castings which have been repaired by this process are shown in Figs. 12, 13, and 14.

Fig. 12 shows part of a pinion, weighing some 7 or 8 tons, used for driving a large rolling-mill. Two of the shrouded teeth have been broken, and the broken parts replaced; and as they had not been dressed when the photograph was taken, they can be clearly distinguished.

Fig. 13 shows the driving clutch of a rolling-mill, both of the lugs of which had been worn down to about the same extent. One of these has been built up to its original dimensions and machined before touching the other one, in order to show clearly the work done.

Fig. 14 shows a smaller rolling-mill

pinion with its teeth worn by use. Two of these were for purposes of illustration planed off, and new ones built up in their place, one of which is clearly shown in the photograph.

Butt-welding of bars and rails may be very perfectly effected by heating the joint by allowing the arc to play between them until welding heat is attained, and then pressing them together and hammering the weld. In general, however, for this kind of welding, the Thomson process is preferable.

The Voltex process is very suitable for welding the seams of tubes, and is now in use in Russia for making tubes for conveying petroleum. It is also suitable for lap-welding sheets, tubes, or strips, and through the kind courtesy of Messrs. Siemens Bros. & Co. the writer has been able to obtain photographs, Figs. 15 and 16, taken in the cable-making department of their extensive works at Woolwich, illustrating the use of the process for welding together the lengths of steel strip used for armouring electric light cables.

When one of the coils of steel strip, which are wound two at a time on to the cable, comes nearly to an end the machinery is stopped, a new coil welded on to the old one, and the machinery started again. The joints have to be welded, and not brazed, because the spelter used in brazing would set up galvanic action, with consequent corrosion of the iron when the cable was exposed to the action of water.

Before the introduction of the Voltex Electric Welding process the welding was effected in a small blacksmith's forge, which occupied a considerable amount of time and resulting loss, as during the time occupied by the welding the whole of the cable-making machinery and some six or seven men are standing idle.

The apparatus shown in the two illustrations, Figs. 15 and 16, which was devised by the writer for the purpose, enables the whole operation to be carried out in a few seconds. The two ends to be welded are placed so as to overlap about half an inch, and held in position by a pair of spring clips carried in two vertical standards attached to the bench shown in the illustrations, a pinch of borax being thrown upon the joint to act as a flux.

The strips fixed in the clips ready for welding may be seen in Fig. 15, which shows the workman standing with the tool in his left hand and a hammer in his right hand. Underneath the joint, and

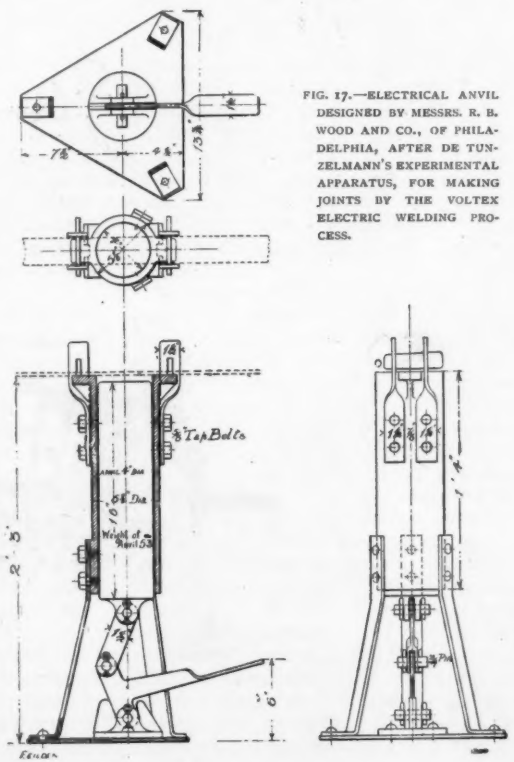


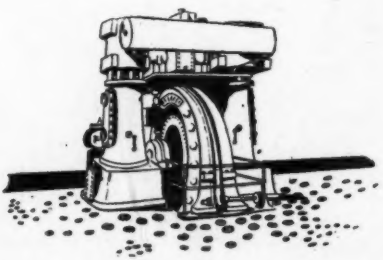
FIG. 17.—ELECTRICAL ANVIL DESIGNED BY MESSRS. R. B. WOOD AND CO., OF PHILADELPHIA, AFTER DE TUNZELMANN'S EXPERIMENTAL APPARATUS, FOR MAKING JOINTS BY THE VOLTEX ELECTRIC WELDING PROCESS.

an inch or so below it, is a movable anvil, which can be lifted up until the strip rests upon it by pressing a foot lever. The workman in Fig. 15 is standing ready with his tool and with his foot upon the lever. He then strikes the arc by pressing a small thumb lever attached to the handle of the tool, and directs the jet of flame upon the joint for a few seconds, raising the metal to welding heat. This stage of the operation is shown in Fig. 16, except that the circuit has been broken to prevent the formation of the arc, which would have made it impossible to get the photograph.

As soon as welding heat is reached, which the workman knows by the joint appearing of a cherry-red colour when viewed through the dark glasses of the protecting mask, the foot lever is pressed, lifting the anvil against the joint, and two or three blows are struck with the hammer, completing the weld.

Fig. 17 shows the details of construction of a movable anvil of a similar character, but for much heavier work. This was designed by Mr. Richard Wood, of Messrs. R. D. Wood and Co., of Philadelphia, after seeing the pattern in use in the writer's experimental laboratory, and was constructed at their works for use with the Voltex welding tools. The illustration is taken from a blue print kindly sent to the writer by Mr. Richard Wood.

(To be concluded.)



Quick-Firing Guns for Field Artillery Use.

By CAPTAIN T. G. TULLOCH, R.A.

❀ ❀ ❀

DURING the present war artillery has played a very important part, and the mass of articles and letters to various magazines and newspapers has shown the interest that not only experts, but also the general public, have taken in this particular arm of the service. Attention has especially been called to the so-called shortcomings of the guns of our field artillery, many writers indeed have stigmatised the weapons as obsolete, and have talked glibly of how foreign nations are now armed with quick-firing field guns. But if these same critics were asked "What is a quick-firing field gun?" doubtless they would be either unable to say at all, or else they would hark back to the old definitions of quick-firing guns which obtained when such were first introduced and applied only to a comparison of guns mounted on carriages or mountings securely fixed in prepared emplacements, such as are found in coast-defence works, or on board ship.

But it is field guns proper on mobile carriages which we are now discussing, and I propose to try and show that a quick-firing gun for field artillery use should deserve its designation as such, not so much on account of its comparative rapidity in loading and firing, but mainly from the fact that the carriage, on which it is mounted, should not recoil; or, rather, that the nett recoil should be nil.

What made the original quick-firing guns, mounted for the most part on immobile mountings, so superior to ordinary breech-loaders was the introduction of the use of "cases."

For the benefit of the uninitiated I must here digress, and explain the various points of difference between an ordinary breech-loader and a quick-firer, both, for the time being, considered as mounted on an immobile mounting. Both systems are breech-loading, but, in the ordinary breech-loader (called B.L.) the escape of gas is prevented by the expansion of an asbestos pad, concentric with the axis of the bore, which expands and takes a seating on the walls of the chamber of the gun. The expansion of the pad—which is of asbestos served with Russian tallow and covered with canvas—is caused by the pressure of the gas on the "mushroom head," the pad being threaded on the stalk of the "head" [*See* Section]. The pad is protected on both sides by dished steel and tin discs, which also expand as the pressure rises. This system is known as the "de Bange," from its inventor, a distinguished French general. All modern breech-loading guns, other than those using cases, are fitted with this system of obturation, which has satisfactorily stood the test of years, both in peace practice and on service.

In order to ignite the charge a "tube" containing mealed powder is necessary the tube being ignited either electrically, or by friction, or by the blow of a "striker." A vent is employed to accommodate the tube, and the charge is contained in a bag of silk which is independent of the projectile. Thus shot, charge, and tube form three separate items, and have to be inserted in the gun one after the other. With the introduction, however, of "cases," the whole three were combined into what is known as "fixed ammunition," *i.e.*, the case contained the charge, the projectile was fixed in its mouth, and the tube in its base, consequently, the rapidity of loading was very much accelerated. The de Bange system of obturation was not necessary, as the case itself, being pressed hard up against the walls of the chamber by the pressure, sealed the escape

of gas in precisely the same way as the cartridge in a sporting gun.

This further simplified the obturator block, as it was not necessary to provide for the longitudinal movement of the mushroom head and stalk. In the Hotchkiss and Nordenfelt systems the actual breech block was simply a block of steel, brought automatically into position and wedging up the case by one movement of a handle. In all modern quick-firing guns, however, other than these, which use case ammunition the system of holding the breech block in position is the same as in the breech-loading guns, viz., the interrupted screw system which is shown in the photograph.

The case system, therefore, introduced the following advantages. It obviated the necessity of an obturating pad and its comparative complications. It did away with vents and tubes. The firing and loading arrangements were greatly simplified, and consequently the rate of fire increased.

In all earlier breech-loading guns the closing of the breech necessitated three distinct motions, first the carrier-ring containing the breech block, mushroom head and pad, etc., had to be swung round till the ring was flat against the face of the breech, the lever had then to be turned to engage the screwed portions of the interrupted screw, and finally the lever had to be folded down, which secured the block from turning, and also brought the "lock" which carried the tube (in the case of axially-vented guns) into the correct position for firing. Some little while ago, however, a single-motion mechanism with a cone breech block, was introduced, in which all these three operations were performed in one motion of a handle actuating suitable levers and "locking" arrangements, and the difference which exists now between so-called quick-firing and ordinary breech-loading guns lies solely in the fact the quick-firing use case ammunition with no obturating pad and fixed ammunition, whilst the breech-loading uses non-fixed ammunition with an obturating pad. The actual means of closing the breech are identical, viz. single-motion breech mechanism and interrupted screw.

The actual difference in the time taken to load by either system is extremely small, a matter of a very few seconds only. These few seconds are of importance, no doubt, in coast-defence guns and on board ship, for several reasons—first, because the targets, such as torpedo boats, are very rapid; secondly, independent firing is permissible, especially with guns in coast-defence works fitted with automatic sights; and, thirdly, because the velocity of the guns on fixed mountings is so very much higher than is possible for field guns, the necessity for careful observation of each shot, and slight corrections of sighting, not being so important, the fire can become more "independent."

No guns above 6-in. use cases in our service, and in the latest of these the use of the case is done away with, so that cases are not used in new guns above the 4·7-in.

Thus, for field artillery work we have a choice of two systems of loading with identical breech mechanism as far as the time taken to close the breech is concerned. The extra few seconds necessary to load the charge and projectile with non-fixed ammunition is of no practical value in this instance, and the question of whether a field gun is a quick-firer or not is entirely one of *recoil of the carriage*, or rather of non-recoil. The question of cases is a somewhat open one, and some continental nations consider them suitable for field artillery use, but we do not. The principal arguments against their use are, that since a case depends for its sealing qualities on its perfect form, such cannot always be ensured, considering the tremendous banging about the ammunition receives when it is taken at a gallop across rough country. Such treatment is also likely to develop any latent cracks, due in some instances to internal stresses in the metal of the case. Cases, too, are heavy, and every extra ounce behind the teams used up by them is regarded with disfavour, implying as it does less ammunition than with "bare" charges and non-fixed projectiles. Horses' feet, too, are liable to damage from cases left lying about.

It is, perhaps, from the fact that we do not call guns which do not use "fixed"

ammunition *quick-firing* guns, which has led many critics to call our ordinary breech-loading guns obsolete compared with those foreign nations which do use such, and the writer cannot help thinking that our Government would be well-advised to call our field guns mounted on non-recoil carriages quick-firing guns. It would satisfy the uninitiated, and would be understood by the expert, and further, would have the merit of being true.

Having seen what the disadvantages of "cases" are, it seems difficult to suppose that anyone who has studied the matter from the British point of view would insist on the necessity of gaining the two or three extra seconds' superiority *as regards loading only* which the use of the case implies. With continental armies the circumstances are somewhat altered, as they are nearer their supplies, and they do not move at such a rapid rate across country as our gunners do.

There is, however, another and very important reason why *very* rapid loading is unnecessary, and it is, that the rate of fire depends upon the rate *at which the time fuse is set*, and the loading of the ordinary breech-loading guns is always faster than this. This is a factor which many people who advocate an extremely rapid rate of fire leave out of their calculations, but it is all important, because the only nature of projectile used for field artillery is "shrapnel," *i.e.* a projectile containing a large number of bullets which is caused to burst in the air short of the target by means of a "time fuse." These shrapnel can also be burst on graze by means of a double-acting arrangement in the same fuse, but such a system, called "percussion shrapnel," is not nearly so effective, as it has no searching effect on men behind trenches. The rate of fire of field artillery is also limited by the time taken to observe the effect of each shot, which is an absolute necessity if the enemy are on the move.

It will be apparent, therefore, that the term quick-firing as applied to a field gun is a misnomer, if it implies solely the degree of rapidity of loading, and we get down to the bed rock of solid fact, namely, that a *quick-firing field gun is one which is mounted on a non-recoil carriage.*

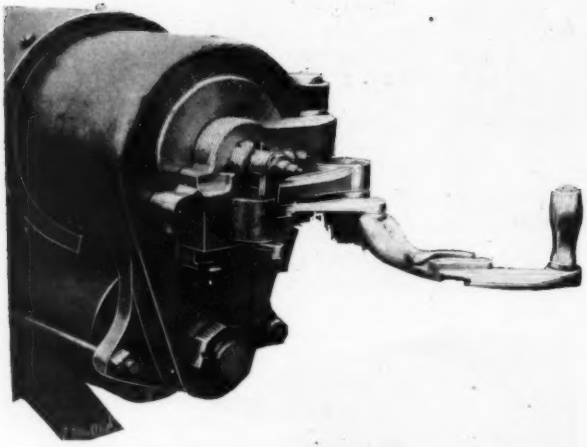
NO. 1.—SINGLE-MOTION MECHANISM, SHOWING BREECH-CLOSING ARRANGEMENT OF 12-POUNDER 12-CWT. Q.-F. GUN. THE CASE IS SHOWN LOADED.

This system, with "obturating pad" instead of "case," was adopted in the new 14-pounder field batteries raised.

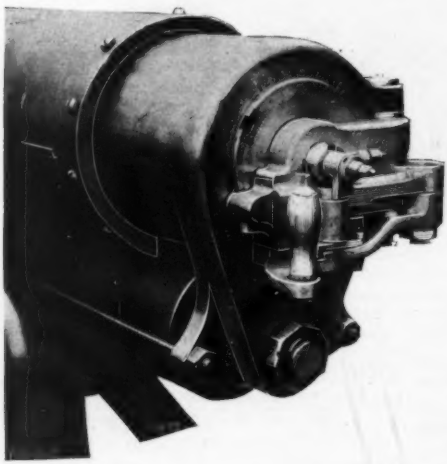
Having conceded this fact, it now remains to be seen how we can get the best value out of our gun, *i.e.* have the largest shell power with the greatest range, without recoil.

Designing a field gun is analogous to designing a man-of-war, that is to say, if we gain in one particular point we must lose in another; there is a happy mean, which is an assemblage of give and take; thus, if we want a very high muzzle velocity without recoil, it is necessary to use either a very light shot or have a heavy carriage.

But here at once we are met with



NO. 2.—SAME GUN AS IN NO. 1 PHOTO, BUT THE BREECH-BLOCK HAS ENTERED THE BREECH AND BEGUN TO BE TURNED BY THE ACTION OF THE SMALL LEVER SO AS TO ENGAGE THE SCREW.



NO. 3.—SAME GUN AS NOS. 1 AND 2. THE BREECH IS NOW SECURELY LOCKED AND THE GUN READY TO FIRE.

difficulties, as a light shot means that, though the *muzzle* velocity may be great the velocity falls off very rapidly, and, at long ranges the remaining velocity may be actually less than that of a heavier projectile starting with a lower muzzle velocity, and consequenty the velocity of the bullets of the former, when the shrapnel bursts, will be considerably less in "man-killing" properties than those of the heavier projectile.

On the other hand a heavy carriage leaves less weight for ammunition, because there is a limit to the weight behind the teams of about 38 cwt. with the gun, ammunition, etc.

Having fixed on our limit of weight behind the teams, the next thing to be settled is the number of rounds to be carried, and consequently the size of the projectile and calibre of the gun. Finally, we arrive at the question of muzzle velocity, which should be as high as possible, and these latter considerations involve the question of the non-recoil of the carriage.

A non-recoil carriage has so many apparent advantages it is needless to dilate fully upon them. Suffice it to say that the detachment are spared the fatigue of running the gun up into position again after each round, the sights are more quickly again aligned on the objective, the gun can be loaded *immediately* after firing, and the fire can be made more rapid.

The following figures will show the enormous amount of energy which has to be absorbed by the mounting when firing, say, a 14-lb. projectile with even as low a muzzle velocity as 1,600 ft. per second.

Suppose the gun to weigh 7 cwt., *i.e.* 784 lbs., the velocity of recoil of the gun as the shot leaves the muzzle is

$$\frac{1{,}600 \times 14}{784} = 28{\cdot}6 \text{ ft. per sec. nearly,}$$

and therefore the energy of recoil is

$$\frac{784 \times (28.6)^2}{64.4}$$

= 10,000 ft. lbs. approximately.

This gives some idea of the difficulty in designing a carriage which shall not recoil, and the difficulty is further accentuated by the fact that recoil must not take place on any ground whether rocky or sandy. It is a problem which is puzzling the ingenuity of all artillerists both at home and on the Continent, and one before which questions of a few seconds of difference in time of loading or firing pale into insignificance. It is impossible to "anchor" the carriage, as this would take too much time in coming into action, and would delay a retirement, consequently recourse has to be had to some other means of checking recoil.

The main feature of all systems hitherto put forward is the "spade," which is attached, either rigidly or by means of springs, to the trail; on shock of discharge the recoil of the carriage causes this spade to dig into the ground, and further motion of the carriage is thus arrested. With a well-designed carriage the nett recoil, after the first round has firmly embedded the spades should be nil. Broadly speaking, the various systems of using the spade may be resolved under two heads. First, those in which the gun alone recoils at first against the action of springs, or hydraulic buffers, so that the jar upon the carriage is eased down, and the energy of recoil of the gun is *gradually* communicated to the axletree, wheels, and trail, thus offering fresh weight for the energy to expend itself upon. In this instance, the spade is rigidly fixed to the trail.

Second, those in which the gun on firing carries back with it, without any springs or buffers (or perhaps only very short ones), the axletree, and consequently the wheels and also the trail. In this case it is necessary to provide the spade attachment with some spring arrangement, which performs a double function, viz. it eases the blow on the spade and prevents its tearing its way through the ground or being broken, and also runs up the carriage again into the firing position. A comparison of the two general systems is interesting.

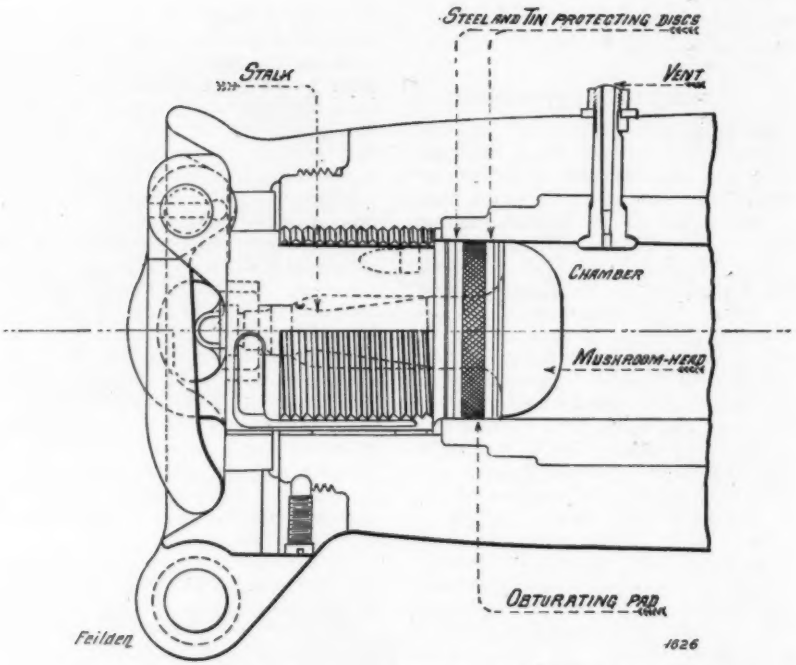
In the first the gun recoils practically alone for some appreciable time, and the energy of recoil is but slightly diminished during that time; it is evident, therefore, that the weight of the carriage is not used at first for absorbing the energy, which is a distinct waste of weight. It also implies that, in order to destroy the energy of recoil of the gun and bring the strain on the mounting gradually, it is necessary to have extremely long buffers or springs. To such an extent has this been carried that in one French model under trial for its Government, the recoil of the gun itself is no less than 3 ft. 6 ins. Such a length is altogether out of place in a field gun for many reasons, one of which is that buffers of such a length are more likely to get out of order, and also offer a bigger target. It is, too, very detrimental to accuracy of shooting, implying as it does want of rigidity on firing.

On the other hand, the "fixed spade" is extremely simple, and requires no springs or buffers.

The second system brings the whole weight of the mounting, including gun, wheels, axletree and trail, into play at once, and the energy of recoil is at once begun to be absorbed in moving such a heavy weight. As, however, the whole mounting recoils it is necessary to provide the spade with springs or buffers so that the recoil is gradually destroyed, and, when it is totally so, the springs reassert themselves and run the whole carriage up again into the same position as before firing.

It is on this second system that the design of carriage used by the British field artillery is based, and looking at it purely from a theoretical point of view there is no doubt that it is the best of the two; in addition, however, it has stood the test of war extremely well, and all reports from South Africa are loud in its praises.

It was originally designed as a make shift arrangement by Sir George Clarke, R.E., superintendent of the Royal Carriage Department of Woolwich Arsenal, but so well has it done in war, as well as in competition with several other designs submitted by leading firms in England, that



SECTION OF BREECH-CLOSING AND OBTURATING ARRANGEMENTS IN 14-POUNDER Q.-F. GUN, WITH WHICH OUR FIELD ARTILLERY IS ARMED AT PRESENT.

practically no alterations, so far as the carriage is concerned, are to be made in arming the many new field batteries now being raised.

The only alteration in the guns themselves is the substitution of the single-motion breech mechanism for the three-motion, thus putting the new equipment practically on a par with the "case" system of fixed ammunition as regards rapidity of loading. Thus it comes about that whilst many people are calling our field guns obsolete, and urging upon the authorities to equip the gunners with quick-firing guns, we are actually engaged in a war in which to all intents and purposes, as far as the carriage is concerned, we are really using quick-firing field guns.

Such, then, is a brief *résumé* of the broad general principles of quick-firing guns for field artillery, looked at from the point of view of the actual gun and mounting itself. There are many other considerations involved, such as the supply of ammunition, but this in itself is a subject apart; but it may be remarked in passing that enormous rapidity of fire is useless unless accurate, and that, as rapidity increases accuracy falls off, and here again we must strike the happy mean, and combine as far as possible accuracy and rapidity. If, as some people think right, our guns were able to fire say, 20 shots a minute, in a very short time ammunition would be exhausted or else enormous supplies of it would be necessary. For an army far from its base, as ours generally is, the difficulties of transport would be stupendous, but, even leaving this factor out of the question, it is better to fire, say, four shots a minute accurately than 20 ineffective ones.

Accuracy is of first importance, and is embodied very neatly in a saying of Prince Kraft, the great German Artillery General, namely, that the three duties of artillery are first to "Hit," second to "Hit," and third to "Hit."

The sketch of a section of the breech-loading and obturating arrangements of the guns as at present used by our field artillery, shows the old system of cylindrical breech block, and three-motion mechanism. The other three photographs show the new single-motion breech mechanism with coned breech block. The photos are of a "case" gun of 12 cwt., projectile 12 lbs., such as is used on board ship and in coast-defence works, and also by the naval forces landed in South Africa. The addition of an obturating pad somewhat similar to that shown in the section allows of non-case ammunition being used, and it is this latter system that will obtain in our new field guns. Broadly speaking, the breech *actions* are identical for small quick-firing and breech-loading guns.

The three photographs illustrate the single-motion mechanism in three positions. The handle of the long lever is swung from right to left, the first portion of the swing inserts the breech block, the screwed portions of the block fitting into the plain portions of the breech; the second portion of the swing actuates the small lever, which will be noticed near the far end of the large one, causing the block to turn and so engage the screw portions of the breech and block; the third portion of the swing locks the lever securely in position and brings the firing arrangements correctly into position for firing, previous to which they are at safety, so that the gun cannot be fired till the breech is securely closed.

F. G. Fullock

Piece-work.

By CLAUDE W. HILL, A.M.INST.C.E., M.INST.E.E.

MR. HILL is an Associate Member of the Institution of Civil Engineers and a Member of the Institution of Electrical Engineers. He has had many years' experience as manager of engineering works, and is now engaged in consulting work in London.

DURING the last few years, and more especially since the engineering strike, articles have appeared in the technical magazines in which the advantages of various forms of piece-work have been demonstrated.

The articles have mostly dealt with the general principles rather than with the details of the system necessary for the establishment of piece-work in any given shop, and principals of firms who have been led to feel that the adoption of piece-work would be to their advantage have asked me how they ought to go about it, how to divide their work and price it, what system to adopt in paying the men, and how to avoid confusion when, owing to urgent repair work coming in, the men have to temporarily put their half-finished piece jobs on one side. It would be impossible to answer these questions in a manner which would be applicable to all cases, but in this article I propose to answer them in a brief and elementary manner, giving a few illustrations of the method of estimating piece-work prices and of the forms and rulings necessary.

Piece-work may be broadly classed under two systems. The first, with which I do not propose to deal at any length, is that in which a foreman or leading hand undertakes a complete job—say the plating of a ship's hull, the building of an engine, or the construction of a switchboard—at a price settled between himself and his employer, taking the work entirely into his own hands, and employing and paying the men himself. Such a system has the advantage that it saves the employer a lot of trouble, as it enables him to know what the job is going to cost, and saves him all the trouble of organising and carrying through the labour portion of the work; it also offers the advantage that it can be adopted in any shop at any time without calling for any alteration of the shop system. Its disadvantage is that it creates conflicting interests, and sets up in the works an authority distinct from and possibly opposed to that of the employer, and should the foreman leave or die, his department is thrown into confusion for some time. It is sometimes urged as a further disadvantage that it enables the foreman to make a lot of money over and above his regular salary. Whether this is to be regarded as a disadvantage depends on the point of view. Under this system the employer practically deputes a portion of his duties and responsibilities to his foreman, and it seems only reasonable that a portion of his profits should be diverted into the pockets of the

man who undertakes those duties and responsibilities.

The second system, with which I propose to deal somewhat fully, is the piece-work system proper, in which the construction of any given machine or other piece of work is divided into its several processes as performed by each individual workman, a definite price being assigned to each process, and this price being paid to the workman himself by the employer. Under this system the foremen take no part in the piece-work, but usually their salaries are supplemented by a commission or bonus, the amount of which depends upon not only the quantity, but the quality, of the work turned out by their departments, thus making their interests identical with that of the employer. The advantage of this system is that each workman gets paid according to his ability and merits, and not according to the trade to which he nominally belongs.

A further advantage is that it places the organisation of the works entirely in the hands of the employers and their managers, and no confusion need be caused by the loss of any one man or number of men.

One of the first essentials of a successful piece-work system is the establishment of a proper method of arriving at piece-work prices. The usual method pursued hitherto, when prices have to be settled for a new machine, is to either guess at the price from the nearest parallel case in the cost book, or else to put one machine through the shop on time-work, and take the piece-work prices from the booked cost of the time-work. Both these methods are inaccurate and unsatisfactory, especially the latter, for in this a distinct temptation is held out to the men to make the time job last as long as possible so as to get high piece-work prices, after which they take care to do the piece-work itself at a slow rate, only making such profit as will not result in the price being cut.

A more satisfactory system is that in which the price of each process is obtained by tabulating and pricing each of the elementary operations into which it is subdivided. To carry this system into effect it is necessary that speed and feed tables should be prepared for all the machine tools and appliances, and that notes should be taken continuously of the time taken on all elementary hand processes, such as the time taken to put the change-wheels on a given lathe, the time taken to remove a face-plate and put on a chuck, the time taken to move a given weight from one part of the shop to another, and so on. A continuous record of these matters, taken day by day, will not only be useful for settling piece-work prices, but it will also enable the manager to know where time is being wasted and where economy may be effected by improved methods.

The speed and feed tables having been prepared, the calculation of the cutting time of the tools may be effected by very simple formulæ, and if this were all that was necessary the piece-work prices would be a matter of very simple calculation, and could be got out by the draughtsman when getting out his list of quantities and weights. The point of real difficulty is the determination of the idle time, that is to say, the time lost in getting the stuff out of the stores, setting it in the machine, changing tools and chucks and so forth, all of which will take greater or less time, according to the efficiency of the management. The percentage of idle time is a good criterion of managerial ability, for upon it depends to a large extent the commercial success of the concern.

The example marked Form No. 75 (page 413), shows a speed and feed table suitable for a lathe, and requires no explanation, the various speeds, etc., being taken with an ordinary speed counter and stop watch.

Before calculating the time which will be taken to do any given job we must decide upon the cutting speed and rate of of feed. These can only be determined either by experiment or from previous experience as they depend upon many conditions. The job itself may be of such form as to spring, or even break under the strain of a heavy cut, or its shape may be such that it cannot be held in the machine with sufficient firmness. The strength and stiffness of the machine tool, the chuck or vice, the slide rest and the cutting tool itself must all be considered.

Then again the speed and feed are governed by the degree of accuracy required. In jobs requiring no great accuracy a slight spring does not matter, and a heavy cut may be used; but where accuracy is needed spring is not permissible, and light cuts are essential.

In connection with the following formulæ, a few figures as to cutting-speeds and feeds are given. These, however, must not be regarded as rigid figures applicable to all cases, but rather as bases to commence from when experimenting to determine the right speeds for new jobs.

LATHE WORK.—The number of revolutions per minute for a given cutting-speed is obtained by Formula No. 1:

$$(1) \qquad R = \frac{3{\cdot}8 \times C}{D}$$

in which R = Revolutions per minute, C = Cutting-speed in feet per minute, and D = the diameter of the job in inches. The speed so found will probably not coincide with any of those on the S. and F. table, but of course the nearest is taken.

The time required for each traverse is then found by Formula No. 2:

$$(2) \qquad T = \frac{L}{R \times F}$$

in which T = time in minutes, L = length of the traverse in inches whether sliding or surfacing, and F = the feed in inches per revolution.

Example.—A shaft 2″ diameter to have a cut taken along 36″ of its length. C 22 ft. per minute. F ·032″ per revolution.

$$R = \frac{3{\cdot}8 \times 22}{2} = 41\tfrac{1}{2} \text{ Revs. Nearest} = 40.$$

$$\text{Time} = \frac{36}{40 \times {\cdot}032} = 28 \text{ minutes.}$$

Cutting-Speeds.—Cast iron, 30 ft. to 36 ft. per minute. Steel, 16 ft. to 26 ft. Hardened steel and chilled iron, 13 ft.

DRILLING.—Formulæ Nos. 1 and 2 apply to drilling, C being the cutting-speed at the periphery of the drill, R the revolutions per minute of the drill, and L the depth of the hole.

Cutting-Speeds and Feeds:

Dia. of Drill.	Wrought Iron. C.	F.	Cast Iron. C.	F.
⅛″ to ¼″	20 ...	·0035	16 ...	·0045
¼″	20 ...	·005	16 ...	·00625
¼″ to ½″	20 ...	·0075	16 ...	·00875
½″ and over	20 ...	·010	16 ...	·0125

Example.—Hole ⅞″ diameter 3¼″ through in wrought-iron.

$$R = \frac{3{\cdot}8 \times 20}{{\cdot}875} = 87{\cdot} \quad \text{Nearest} = 90.$$

$$T = \frac{3{\cdot}25}{90 \times {\cdot}01} = 3\tfrac{3}{4} \text{ minutes.}$$

MILLING.—The speed of cutter in revolutions per minute for a given cutting-speed is given by Formula No. 1, in which C equals the cutting-speed at the periphery of the cutter, and D the diameter of the cutter. In preparing the Speed and Feed List, the feed of the table in inches per minute with the belt on the different cones should be taken. The time taken for a given traverse is then given by the Formula No. 3,

$$(3) \qquad T = \frac{L}{F}$$

in which F is the feed of the table in inches per minute.

An excellent Treatise on the use of Milling Machines is issued by Messrs. Brown & Sharpe, in which a number of examples of cutting speeds and feeds on various jobs are given, and there are also examples of speed and feed tables for several sizes of machines.

PLANING.—As planing machines are set to run at one speeed only, the preparation of their speed and feed tables is a simple matter. The time taken for a traverse is given by Formula No. 4.

$$(4) \quad T = \frac{{\cdot}083 \times W \times L \times (1 + r)}{C \times F} \times X$$

in which W = width in inches of the surface, L = the length of stroke, r = the ratio of the quick return, C = the cutting speed in feet per minute, F = feed in inches per cut, and X a constant depending on the loss of time at each reversal, and which

must be determined by experiment for each machine.

Example (*A*).—Surface 72″ by 36″ wide, *C* 20 ft., *F* ·0625. No quick return. *X* say 1.05.

$$T = \frac{\cdot 083 \times 73 \times 36\cdot 25 \times (1 + 1)}{20 \times \cdot 0625} \times 1\cdot 05$$

$$= 369 \text{ mins.}$$

(B) Same job but with quick return, having a ratio of 1 to 4.

$$\text{Time} = \frac{\cdot 083 \times 73 \times 36\cdot 25 \times (1 + \frac{1}{4})}{20 \times \cdot 0625} \times 1\cdot 05$$

$$= 230 \text{ mins.}$$

Here we see the advantage of the quick return.

Slotting and Shaping.—There are two methods of driving the rams of Slotters and Shapers. In one the ram is driven by a screw with a reversing motion similar to that of a planer. This offers the advantage of a uniform speed of tool throughout the stroke, but as the reversal is dependent on momentum it does not take place at exactly the same point at every stroke, so that clearance must be left for the tool at both ends, and this renders this class of machine unsuitable in those cases where the tool has to move within definite limits. For these machines, Formula No. 4, applies the same as for planers.

In the other class of slotters and shapers the ram is driven by a crank and connecting rod, a quick return being generally obtained by driving the connecting rod through a link instead of attaching it directly to the crank pin. These machines have cone pulleys, and the stroke of the connecting rod can be varied so that a number of cutting speeds can be obtained. In preparing the speed and feed table the number of revolutions per minute of the crank shaft with the belt on different cones should be taken, and the revolutions per minute required for a given cutting speed and stroke are then found by the Formula No. 5.

$$R = \frac{C \times 12}{L \times (1 + r)}$$

in which C = the cutting speed in ft. per min., L = the stroke in ins., and R = the ratio of the quick return. It should be borne in mind that in these machines the cutting speed is not uniform throughout the stroke, so that C represents the average cutting speed.

The time required for a complete traverse is given, as before, by the Formula

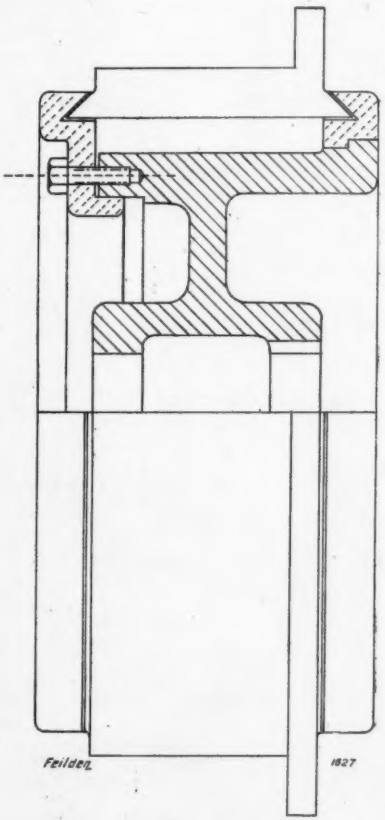


FIG. 1.

No. 4, but omitting the constant X, as there is practically no loss of time at reversal.

In addition to the tools enumerated, there are in every shop others of a special or subsidiary nature, the speeds and feeds of which also require to be determined.

The foregoing formulæ enable us to calculate very quickly the actual tooling time on the different jobs, but this is only one item among the number which go to make up the total time of a job. When a man is given a new piece of work he usually has to go to the stores to fetch it, and when he arrives there a stores man not well acquainted with the work may bring him half-a-dozen articles before he hits upon the right one; or perhaps the workman may stand neglected at the counter waiting till the storesmen finish telling each other fairy tales before condescending to give him their attention. When he gets back to his machine the work has to be chucked or cramped, the tools set and measurements taken. The time of none of these things can be determined by calculation, but it can be determined by a manager who has full power over the drawing-office, works and stores. He can order the work in such a way that the men do not have to go to the stores for their work, but have it laid beside their machines by the labourers in good time;

Feb. 1st, 1900.

SIX 24" COMMUTATORS.—ESTIMATE OF MATERIAL.

Dg. No.	Metal.	Quantity.	Description.	Weight.	Rate.	£	s.	d.
233	Cast Iron ...	6	Commutator Bushes :—	Cwt.				
			122 × 1·25 × 6 × ·00232 ...	2·12				
			100 × 9 × 6 × ·00232 ...	12·52				
			126 × 1·375 × 6 × ·00232 ...	2·41				
			39 × 3·75 × 6 × ·00232 ...	2·03				
			29 × 4·5 × 6 × ·00232 ...	1·81				
				20·89	11/-	11	9	10
,,	Steel Casting ...		Back Rings :—					
			77 × 1·5 = 115					
			84 × 2·25 = 189					
			304 × 6 × ·00257	Cwt. =4·69	23/-	5	8	0
,,	,, ,, ...		Front Rings :—					
			77 × 1·5 = 115·5					
			62 × 2·25 = 139·5					
			88 × 1·25 = 110·0					
			45 × 2·25 = 101·0					
			466 × 6 × ·00257	=7·18	23/-	8	5	3
,,	Steel Set Screws	16 × 6 = 96	Hexagon Set Screws :—					
			$\frac{5}{8}''$ × $2\frac{1}{4}''$	...	36/-	1	4	0
,,	Mica	240 × 6 = 1440	Micas with lugs joined on ...	...	9½*d.* ea.	57	0	0
,,	,, ...	2 × 6 = 12	Moulded End Insulators ...	...	20/- ea.	12	0	0
,,	Copper ...	240 × 6 = 1440	Copper Bars with solid lugs :—					
			·2525 × 1·875 × 9 = 4·261					
			·305 × 2·125 × 1·125 = ·729					
			1440 × ·3 × 4·99	lbs. =2115	1/3	134	14	0
			Allow for unbooked material (Brunswick black, &c.)			5	0	0
						£235	1	1

FORM NO. 4.

he can also see that only men are employed in the stores who have been through the shops and know the names and appearance of all the goods used, and he can also, of course, suppress fairy tales and gossip. A tool-room and regular supply of tools to the men without the necessity of their taking them to be ground or dressed, is a natural accompaniment of piece-work.

The provision of time-saving chucks, tool-setting arrangements and measuring instruments lies entirely with the manager.

For these reasons the predetermination of the piece-work rates must lie with the manager and his staff with whom will also lie the work of recording continuous observation of the time taken on the work as it proceeds.

I will now give a brief sketch of the system of preparing piece-work prices, and will give as an example a comparatively simple job,—the construction of a 24-in. commutator for a dynamo. Fig. 1 shows the commutator in sufficient detail for our purpose. When preparing the schedule of piece-work prices it is desirable to prepare at the same time a complete list of the materials with their weight and cost so that the total cost of the contemplated work may be obtained and alterations made if it is found excessive.

The particulars should be entered into a book of which form No. 4 forms the left-hand page of the folio, and Form No. 76 the right-hand page.

Form No. 4 contains the list of quantities of the job together with the weights and prices. In the illustration these have been filled in and do not call for any special comment.

Form No. 76 contains the schedule of piece-work prices estimated in detail, the cutting time of the different tools having been calculated from the formulæ already given. The schedule for the complete commutator has been prepared, but the first page only is given here, as it is quite sufficient to illustrate the system.

Prices have similarly been prepared for the turning, boring, and drilling of the steel rings, the gauging of the bars and micas, the straightening of the bars and milling for the armature connections, the

Machine Tool No. *Date,*

Speed of Countershaft *Revs. per min.*

Size of Countershaft Pullevs

SPEEDS			FEEDS IN INCHES PER REVS.				REMARKS
Counter Shaft / Spindle	REVS PER MIN.		Spindle / Feed Shaft	SLIDING		SURFACING	
	WITH BACK GEAR	WITHOUT BACK GEAR		GEAR IN.	GEAR OUT	GEAR IN	GEAR OUT

FORM NO. 75.

SIX 24" COMMUTATORS.—ESTIMATE OF LABOUR. *Feb. 1st, 1900.*

Dg. No.	Piece.	Process.	Hours.	Rate.	£ s. d.
233	C. I. Bush	1st.—Bore and clean up one side on Boring Mill :—			
		Prepare machine and set tools 20			
		Lift job on machine and set ... 10			
		Rough boring cut 4			
		Fin. ,, ,, ... 7			
		Face boss 4			
		Turn ,, ... 7			
		Face rim 9			
		Bore inside rim 22			
		Face web 16			
		Take off sharp corners ... 5			
		Allow for changing speeds ... 5			
		Put job back on floor 5			
		94 × 6 = 564			
		Allow for delays 30			
		Turret Boring Mill ... ... 614 =	10¼	1/-	0 10 3
		2nd.—Turn remainder of surface in 18" Lathe with capstan rest :—			
		Prepare lathe and set tools 30			
		Place on mandrel between centres 15			
		Face boss 4			
		Turn ,, ... 7			
		Face rim to dimension 9 × 2 = 18			
		Rough bore inside rim... ... 13			
		Fin. to template do. 13			
		Getting dimension 5			
		Turn rim—*A.* 1st rough ... 5; 2nd fin. ... 5; Get dim. ... 5			
		B. 1st rough ... 36; 2nd fin. ... 5; Get dim. ... 5; 3rd rough ... 32			
		Corners 5			
		Moving turret and straps ... 10			
		Take out and remove mandrel 8			
		191 × 6 = 1146			
		Allow for delays 30			
		18" Lathe ... ... 1206 =	20¼	1/-	1 0 3
		3rd.—Mark off from template 16 holes ⅝" tapping and one keyway 1" × ½" :—			
		Marker off ... ... 20 × 6 = 120 =	2	1/-	0 2 0
		4th.—Drill and Tap :—			
		Prepare machine 15			
		Put job on table 5			
		Set 1			
		Drill tapping hole ... 1			
		1st tap 3			
		2nd ,, ... 3			
		Changing taps and speeds 2			
		10 × 16 = 160			
		Put job on floor 2			
		6 × 167 = 1002			
		Allow for delays 30			
		Drilling Machine ... ... 1047 =	17½	1/-	0 17 6
		5th.—Cut keyways in Slotter :—			
		Slotting machine	2	1/-	0 2 0
		Carried forward			£2 12 0

SIX 24″ COMMUTATORS.—TIME SUMMARY. Date, *Feb. 1st, 1900.*

	Boring Mill.	18″ Lathe	Marker Off.	Drill.	Slotter.	Milling Mac.	Com. Bench.					
C. I. Bushes ...	10½	20¼	2	17½	2	...	...					
Steel Back Ring	8½	10	...	...	...	...	...					
,, Front ,,	8	15	2	10	...	...	...					
Bars	...	...	...	...	...	90	60					
,, ...	...	...	...	...	...	...	20					
,, ...	...	...	...	...	...	...	20					
Micas	...	...	...	...	...	...	20					
General ...	...	30	...	...	...	...	108					
,, ...	...	35	...	...	...	...	9					
	26¾	110¼	4	27½	2	90	237					

FORM NO. 77.

complete assembling of the six commutators and final turning, polishing and painting.

A few words may not be out of place here respecting the machines and methods assumed in preparing these prices.

LIFTING TACKLE. — Each machine should have a handy jib or girder with a light block or compressed air cylinder to lift the work, so leaving the shop traveller free to deal with heavy jobs only.

BORING MILL.—This should have jaws (preferably self-centring) on the face plate, and a turret to take the tools so as to save time in tool changing.

LATHE.—In order to save time in tool changing this should have a turret, preferably square, so that the tools can be brought close up to the job, so avoiding spring. For the turning of the 45 degs. cones and recesses the top rest should be set over by the tool maker accurately, and then a steady pin-hole drilled and rymered through the top and bottom swivel plates, so that the top rest can in future be set to 45 degs. accurately without loss of time.

DRILLING AND TAPPING.—In this work it is desirable to tap the holes immediately after they have been drilled and before the job has been moved, so as to ensure the taps being concentric with the holes. The tapping chuck should therefore be arranged so that the drills and taps can be changed in it instantaneously. It

1/2/1900.

No. 62. *Name*, W. Jones. *Trade*, Machinist.

Order No. D.O. 25. *Dg. No.* 233.		*Revs.*	*Feed.*
Six 24″ Com. Bushes :—			
	Bore	18	1″/16
	Finish 4″ T.	18	1″/32
Rough	Face and Turn Boss	9	1″/16
Rough	Face and Bore Rim	4	1″/16
Rough	Face Web	4	1″/16
	Take off corners		

Price for the job, 10/3.

Finished, 2/2/1900.

Inspected and found correct, J.W.M.

Entered in Piece-work Ledger, 2/53.

FORM NO. 42.

No. 62. *Name*, W. Jones. *Trade*, Machinist.

Date, Feb. 1st, 1900.

Order No.		Description.	HOURS. Ordinary.	Time and Quarter.	Time and Half.
D.O.	25	Six 24" Com. Bushes, P.W.	5½		
D.O.	36	Bore, &c., pulley, and reset machine for P.W.	4		

Foreman's Signature, J.L. *Total Hours*, 9½.

Correct with Lodge Book, P.R.

Time and Wages Book, 3/21.

FORM NO. 40.

No. 62. *Name*, W. Jones. *Trade*, Machinist.

Order No.	Description.	T.	F.	S.	M.	T.	W.	Hours.	Time or Piece.	Piece-work Ledger.	Prime Costs.	Lodge Book.	Rate.	Charged. £ s. d.	Uncharged. £ s. d.
D.O. 25	Six 24" com. bushes	5½	4¾	...	...	...	...	10¼	P.	...	...	...	9d.	0 7 8	
D.O. 36	Bore, &c., pulley, and reset mac.	4	...	...	...	...	...	4	...	...	...	...	...	0 3 0	
D.O. 25	Six 24" com. rings, back ...	...	4¾	3¾	...	...	...	8½	P.	...	...	...	...	0 6 4	
D.O. 25	,, ,, ,, ,, front ...	...	...	2¾	5¼	...	..	8	P.	...	...	...	...	0 6 0	
D.O. 49	Flywheel	...	...	...	4¼	9½	3½	17¼	P.	...	...	...	...	0 13 0	
G.M. 13	Coupling	...	...	...	...	...	6	6	...	...	...	...	...	0 4 6	
	Week ending Feb. 7th, 1900	...	...	...	...	...	...	...	...	...	...	...	...	2 0 6	

FORM NO. 41.

should also have a reversing motion within itself so the tap can be run out without having to reverse the machine, and it should also have a friction clutch to prevent breakage of taps.

The machine should be fitted with speed-changing gear, by means of which the speed can be changed instantly from tapping to drilling and *vice versâ* without having to change the straps.

STORES.—Stores orders for the various materials required should be handed to the foreman labourer, and it should be his duty to see that they are obtained from the stores and laid by the machines in good time, so that the machine men may

No. 62. *Name,* W. Jones. *Trade,* Machinist

Wages Paid on Account.						Piece-work Finished.					
Date.	Order No.	Description.	Wage Book.	Time Book.	£ s. d.	Date.	Order No.	Prime Costs.	£ s. d.
Feb. 7	D.O. 25	Six 24" Com. Bushes ...	...	3/21	0 7 8	Feb. 2	D.O. 25	...	0 10 3
	,,	,, ,, ,, back rings ...	...	,,	0 6 4	,, 3	,,	...	0 8 6
	,,	,, ,, ,, front ,, ...	...	,,	0 6 0	,, 5	,,	...	0 8 0
	,, 49	F.G. wheel	...	,,	0 13 0	,, 7	,, 49	...	0 17 3
,, 14	,, 57	Couplings	...	,,	0 15 0	,, 10	,, 57	...	0 19 6
	,, 62	Armature frames	...	,,	0 17 6	...	...	...	...
,, 21	,, 62	,, ,, ...	...	,,	0 5 0	,, 15	,, 62	...	1 7 6
	,, 60	Pulleys	...	,,	1 5 3	...	...	...	...
,, 27	,, 60	,, ...	...	,,	0 2 6	,, 23	,, 60	...	1 14 0
	,, 65	Steel rings	..	,,	1 0 3	,, 27	,, 65	...	1 5 0
		Balance	6/14	...	1 11 6	...	...	...	...
					7 10 0	...	...	...	7 10 0

FORM NO. 43.

go straight on from job to job without loss of time. For the same reason their piece-notes should be given to them in advance, so they will see what jobs they have before them ; and if they do not see the material coming round they can speak to the foreman about it in good time.

It will be noted on the schedule of piece-work prices that for each process the name of the tool is entered on the same line as the number of hours which the process will take.

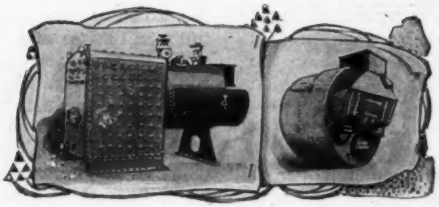
From these entries a summary is prepared, Form No. 77 (page 415), which shows at a glance the total amount of work for the shop in any given job. With summaries of this form for all the work in the shop, the manager can see at once what work he has before him, and how many hours it will take to finish ; and, bearing in mind the dates given for delivery, he can see whether any (and if so which) portion of the shop will have to work overtime to keep to promises.

The book-keeping system necessary for the determining of piece-work balances and for keeping the men's wages straight when, owing to urgent repair work they have to temporarily put their piece-work on one side and take time work, need not be at all complicated. Form No. 42 (page 415) gives an example of a piece ticket, and it is filled up with the particulars of the boring-mill work on the 24-in. commutator bush. For the man's guidance when setting the machine the speeds and feeds are given, and as he has a copy of the speed and feed table he sees at once on which steps of the cones to put the straps. Form No. 40 shows the daily time-ticket which the man fills up and leaves at the lodge when he goes at night. Each morning the time as entered by him on the ticket is checked against the lodge-book and then entered into the time-book, Form No. 41, in which an illustration of a complete week's entries is given. From the time-book the piece-work items are posted into the piece-work ledger, Form No. 43, in which an illustration of entries for one month is given. Each month the balance is transferred to the wage-book and paid to the man.

As this article is intended to deal only with piece-work, and not with the general subject of works management, I do not propose to give examples of the wage-book and prime-cost books, into which the entries in the time-book and piece-ledger are further posted. Before concluding, however, I wish to point out that a system of prime cost, to be of any value, must balance against the commercial books. That is to say, the total amount paid for

labour, as given in the prime-cost summaries, must tally with the total of the wage-book and cash-book. In the same way the total value of material as given in the prime-cost summaries must tally with the total of the stores day-books and with the total purchases in the firm's day-book, plus and minus the amounts of stock at the commencement and end of the period being dealt with.

Claude W. Hill



The Central London Railway.

By W. N. TWELVETREES, M.I.Mech.E.

(Continued from page 319.)

The station buildings, erected under the superintendence of Mr. H. B. Measures, architect to the Electric Traction Co., are necessarily of somewhat unassuming character and are more or less of uniform design. At the generating station and depôt there are buildings of considerable proportions, but these are designed with an eye to utility rather than to architectural effect. The most interesting of all the stations is that at the Bank. In the right-hand corner of Fig. 1 (page 316) is a plan indicating the position of this station, which it will be seen is completely surrounded by a series of subways, serving the double purpose of giving access to the station and of permitting foot passengers to pass from one side to the other of the most crowded and perhaps the most dangerous place in all London, at any rate to timid and non-agile persons. Near the steps of the Royal Exchange there are two passages, each ending in a flight of steps leading into the oval subway. Turning to the left, the passenger will find another flight of steps leading to the street just in front of the premises occupied by the Liverpool and Globe Insurance Company. Continuing in the same direction, the next communication with the pavement above will be found at the north-east corner of the Mansion House, in what is officially described as Mansion House Place.

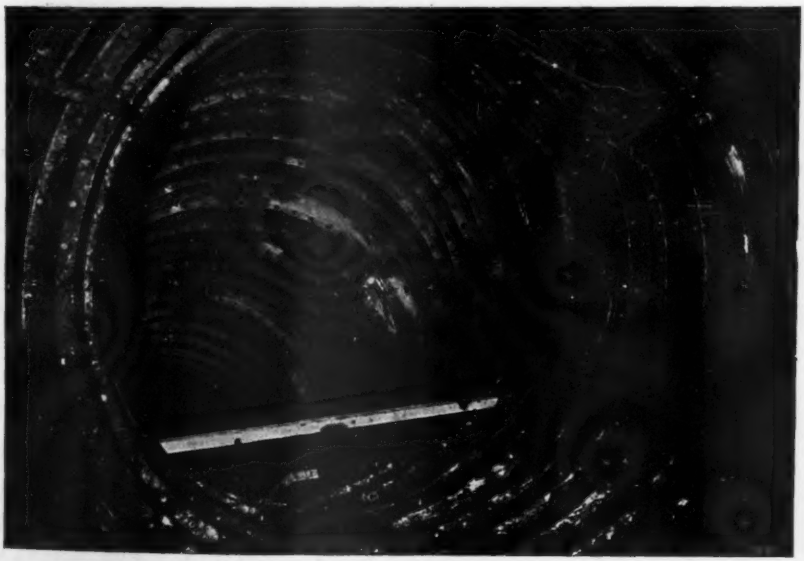


FIG. 2.—VIEW OF IRON-LINED STAIR-PASSAGES FROM PLATFORM-TUNNELS TO LIFT SHAFTS ON THE C.L.R.

FIG. 3.—ONE OF THE STATION-SITES DURING THE CONSTRUCTION OF THE C.L.R.

Beyond this point the subway curves towards the north, passing beneath the well-known space with the little-known name of Mansion House Street, at the junction of the Poultry and Cornhill. Here a corridor will be seen leading in a westerly direction to the terminus of the City and Waterloo line. From this corridor a passage to the left terminates in steps leading to the corner of Walbrook, and a passage to the right furnishes access to the pavement at the confluence of Queen Victoria Street and the Poultry. The last connection with the street above is immediately in front of the Union Bank of London, and beyond this point the subway continues until the oval is completed near the Royal Exchange. The whole of these subways are very close to the street level; they are fully 15 ft. wide; and are well lighted with incandescent electric lamps. When first opened very little use was made of the tunnels, as many strangers to the City believed them to be merely intended for passengers by one or other of the low-level railways. At the present time, however, the public has discovered the true purpose of the passages, which constitute a reform, often discussed by the Press, but never thought worthy of adoption by the municipal authorities. Beneath the subway for foot passengers there are other subways devoted to various conduits for municipal services.

Within the oval subway is the Bank station, the offices of which are immediately beneath the roadway, and from the centre of the station five wells descend, provided with electric lifts, to the underground passages leading to the platforms, which at this particular point are 65 ft. below the surface of the streets. The other stations along the line are more or less alike, although, of course, the actual disposition of each station must vary to suit the site available on the surface, the depth of the permanent way, and the relative positions of the up and down tunnels. Fig. 2 is a view at one of the stations, of an iron-lined staircase passage between the platform tunnels and lift-shafts, looking down the staircase tunnel from the

curved passage. Besides the Bank Station, which is equipped with five electric lifts, five of the stations have four, and the others three each. Altogether, 48 lifts, varying in capacity from 50 to 90 persons each, have been furnished by the Sprague Electric Company, and erected under the superintendence of Mr. J. R. Furman, M.Am.Soc.C.E., and Mr. G. Rosenbusch, A.M.Inst.C.E. In every case the lifts are fitted with safety gear, automatically gripping the guides in the event of a mishap so as to prevent the possibility of any dangerously rapid descent or ascent. As on the City and South London Railway, staircases are provided for passengers who prefer this mode of access to or from the platforms; the underground passages are extremely commodious, and well lighted by electricity.

We have now lightly sketched the geographical situation of the railway, and referred to those features of the stations which come most prominently under the observation of passengers. It will next be interesting to inquire into some technical matters connected with the construction of the tunnels themselves, and to describe some of the special appliances used for this purpose.

At one time the well-known bed of London clay, of the Tertiary Eocene group, was entirely covered by the Bagshot sands, consisting of sands and gravel, with occasional bands of clay. These sandy beds have long since disappeared from the district below which the Central London Railway runs, where the London clay is now simply hidden by a thin layer of comparatively recent alluvial formation, and of made earth. London clay is a tough, ferruginous clay, impermeable by water, and is interspersed by layers of septarian nodules of impure calcium carbonate. The natural colour of the clay is blue, owing to the presence of carbonate of iron, but when exposed it gradually assumes a brownish tint, as the carbonate changes to peroxide of iron, under the action of the atmosphere. Beneath London the greatest

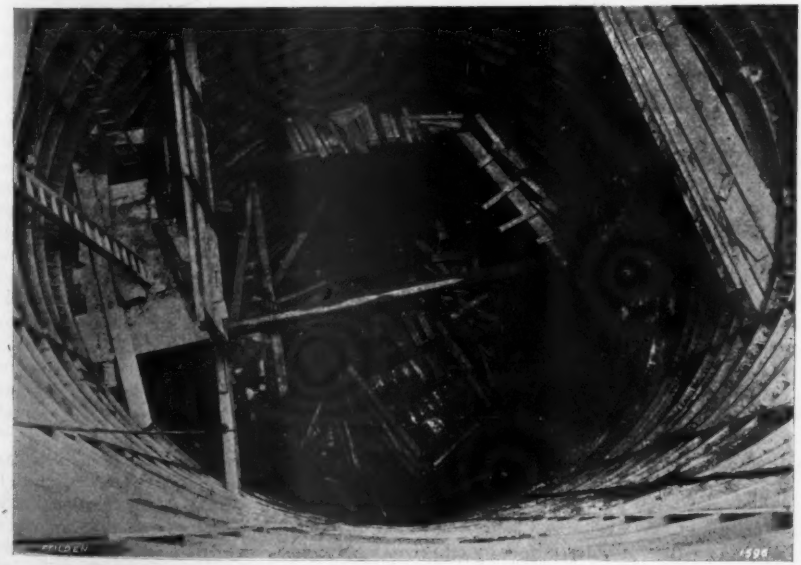


FIG. 4.—PERSPECTIVE VIEW LOOKING DOWN ONE OF THE 30 FT. 0 IN. DIA. LIFT SHAFTS OF THE C.L.R. DURING CONSTRUCTION.

FIG. 5.—ELECTRICALLY-DRIVEN LOCOMOTIVE, 25 H.P., 2 FT. GAUGE: USED IN THE CONSTRUCTION OF 11 FT. 8½ IN. TUNNELS ON THE C.L.R.

thickness of this stratum is estimated at about 420 ft. Near the Oxford Street end of Tottenham Court Road the first three formations encountered are of the following thicknesses:—Gravel and clay 21 ft., London clay 64 ft., Reading beds 51 ft. As the stations in this region vary from 70 to 80 ft. below the surface, it will be evident that it is quite possible for the tunnels to pass beyond the limit of the London clay. In fact, for a short distance, near Berners Street, they pass through the Reading beds; and in one or two sections at the western end of the line water was encountered, in consequence of the proximity of the clay to the overlying gravels. Here and there argilo-calcareous nodules of considerable size were encountered, and although these obstacles caused no serious difficulty, they necessitated the most watchful care on the part of responsible engineers, in order that injury to the shields might be avoided. People who write newspaper articles about modern methods of tunnelling are apt to describe the London clay-bed as a perfectly homogeneous mass through which the Greathead shield cuts its way as easily as a mite does through cheese. The illustration is not precisely representative of the actual conditions, for whilst the mite has no object but to burrow aimlessly in the substance—which is at once its food, its habitation, and its grave—the tunnelling shield is driven to some predetermined point by the application of considerable external force, its operation is assisted by a small army of attendants, and its course is guided from hour to hour and from day to day under the direction of the presiding genius, whose vigilance must be unceasing, and from whom the sense of personal responsibility can never be absent until the appointed task is done.

In the case of the Central London Railway, responsibility has been very much distributed. Upon the engineers acting on behalf of the company devolved the onerous duty of planning the general course of the line along the intended route, and the exact disposition and dimensions of each tunnel; of determining the points at which communication should be made between the up and down tunnels; of designing the passenger stations, with all their auxiliary appliances and machinery, the general depôt and generating station, and the systems by which electricity is led to perform its varied duties along the whole line. Further, they have been responsible generally for matters connected with the permanent ways and the rolling stock, and for the exercise of continuous supervision over the work of the general and sub-contractors. The work of the engineer representing the general contractors has scarcely been less arduous, for his labours have been originative as well as executive. It is well known to every practical engineer how difficult are the problems arising out of matters of detail, and there can be no doubt that the successful completion of so important a work as the railway under consideration necessitates an

immense amount of hard work as well as ability of no mean order. Similarly, the engineers retained by the sub-contractors have each had to bear a heavy burden of responsibility, and this remark applies especially to those who have been concerned in tunnelling operations. Work of this kind is of the highest importance, though it brings no personal glory to the man who has performed it, and when once done it is forgotten and lost to sight as much as are the deeply buried tunnels themselves. The responsibility for the whole of the surface surveys, and for the correct alignment of the tunnels, rested upon the three contractors whom we have previously mentioned, whilst the actual work devolved upon their respective superintending and assistant engineers. Before the work of tunnelling was commenced the surface surveys were completed, and duly approved by the engineers acting on behalf of the company. As the up and down tunnels vary considerably as to their relative positions, the line for the up tunnel only was ranged on the surface, and this line was generally, but not always, the centre line of the tunnel. When such a course became necessary, another line or set of lines was adopted, from which triangulation the actual centre line of the tunnel was obtained, and afterwards set out underground. The centre line for the down tunnel was calculated from the line or lines established by the surface survey. Concurrently with the performance of these technical preliminaries, other matters required attention. Suitable sites had to be secured for the various stations, including sufficient space for the erection of sheds to contain the machinery necessary for supplying the shields and workings with compressed air and electric light; and for the construction of a staging arranged for the reception and expeditious disposal of excavated material. Fig. 3 gives a fairly intelligible idea of the surface works at a typical station. This illustration represents one of the sites during the construction of the railway, showing the

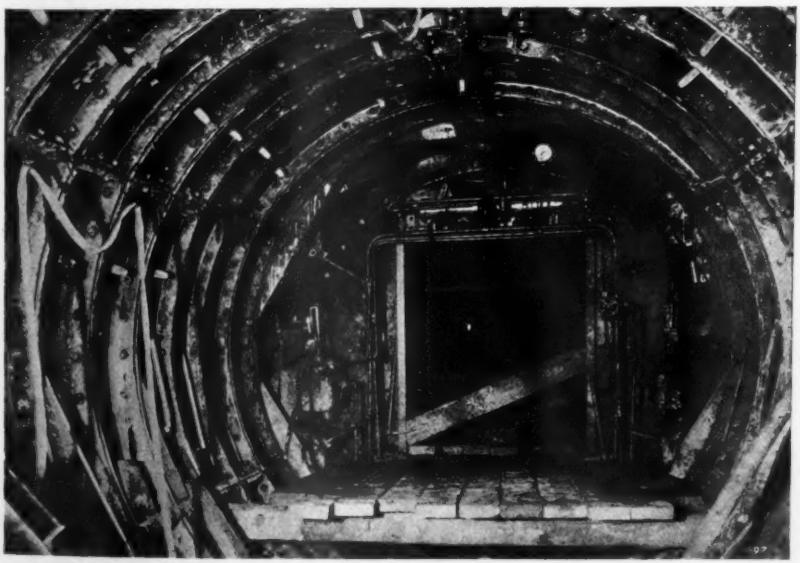


FIG. 6.—VIEW OF AN 11 FT. 8½ IN. TUNNEL ON THE C.L.R. DURING CONSTRUCTION WITH SHIELD, SHOWING ADVANCE HEADING AND OTHER ARRANGEMENTS.

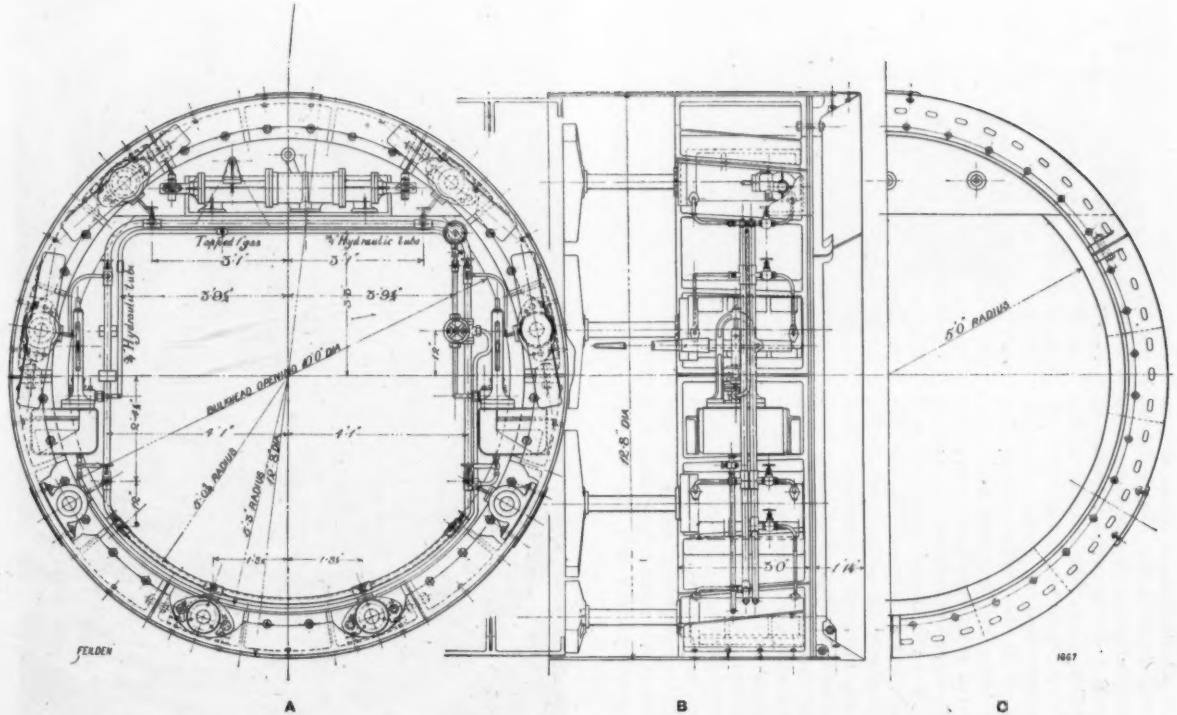


FIG. 7.—C.L.R. SHIELD FOR 12 FT. 7 IN. RUNNING-TUNNEL (SECTION FOR SHARP CURVES). (MAKERS, MESSRS. MARKHAM AND CO., CHESTERFIELD.)
(A) REAR ELEVATION. (B) LONGITUDINAL SECTION. (C) ELEVATION HALF FRONT CUTTING-EDGE.

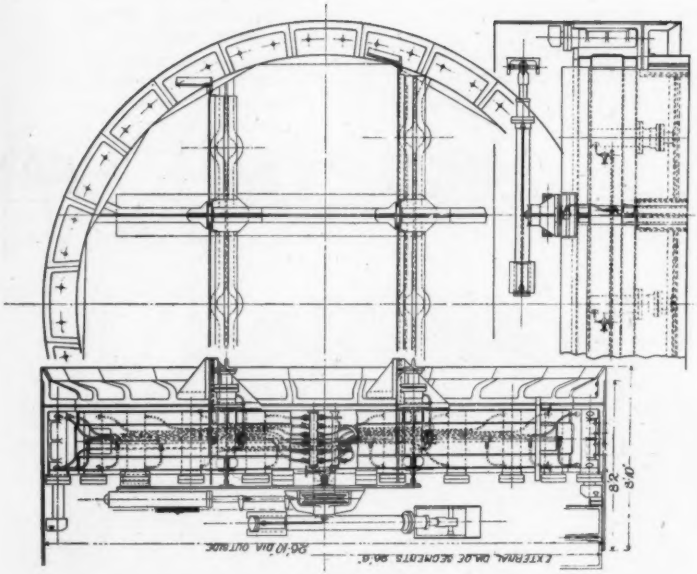


FIG. 8B.—25 FT. CROSS-OVER TUNNEL SHIELD. VERTICAL SECTION, CUTTING EDGE ELEVATION AND FACE-RAM TABLE PLAN.

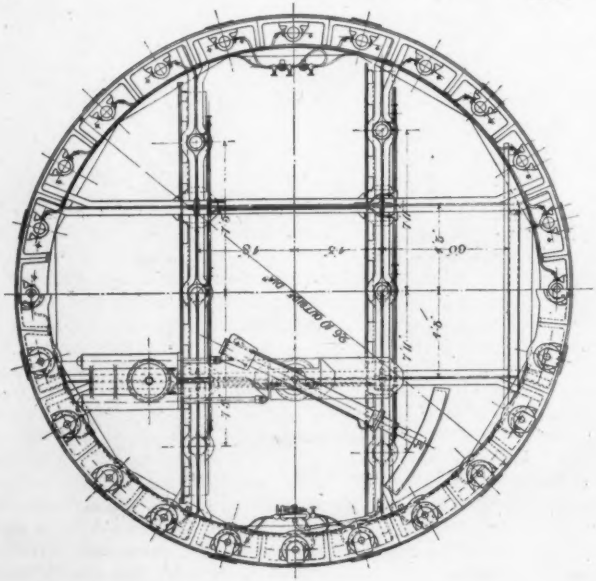


FIG. 8A.—C.L.R. 25 FT. CROSS-OVER TUNNEL SHIELD. REAR ELEVATION. (MAKERS, MESSRS. MARKHAM AND CO., CHESTERFIELD.)

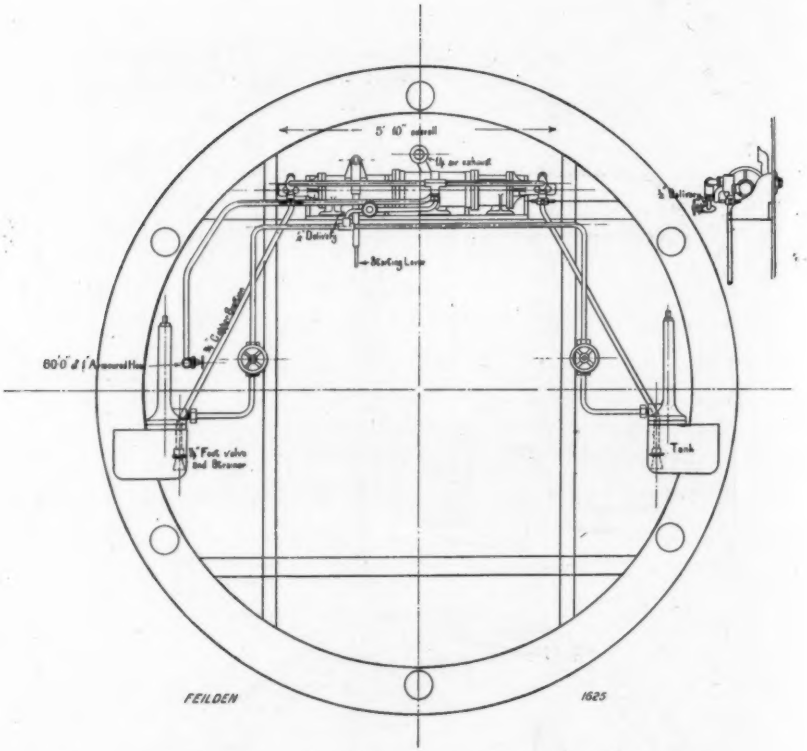


FIG. 9.—C.L.R., PIPE ELEVATION OF AIR-DRIVEN PUMP, ARRANGEMENT FOR SMALL TUNNEL SHIELDS.

headgear, excavation stage, crane for materials, and miscellaneous stores. It was further desirable that the contractor should obtain a site upon which workshops might be erected, and where materials of various kinds could be stored in large quantities. Excellent accommodation of this kind was furnished at Woodhouse Park, Shepherd's Bush, now occupied by the Depôt and Generating Station. Here the contractor for the western section of the line was able to establish his principal workshops, and to store plant and materials, including some 40,000 tons of cast-iron segments ready to be used for lining the tunnels.

Before proceeding to describe the general underground features of the railway, it may be interesting to refer briefly to the manner in which the Greathead shield is first started on its subterranean career. When the site for a station has been secured, the ground is cleared and a shaft is sunk to the station level. This shaft is lined, as shown on Fig. 4, with cast-iron segments, technically known as "tubbing," and into the annular space existing between the metal tube and the clay hydraulic lime is injected under pressure, so that the work may be solid and secure. Immediately the shaft is sunk to the necessary depth a gang of men begin to drive a transverse heading to the street line. Here an excavation, termed the shield-chamber, is made on the axis of the first tunnel to be driven. The parts of the shield are

brought into this chamber, bolted and riveted together in position, and when all auxiliaries have been attached and connection has been made with the mains supplying water and compressed-air the shield is ready for action. As will be seen from several of our illustrations the shield consists of a cylinder constructed of steel and cast-iron, the front edge is fitted with a knife edge, whilst the back end is furnished with a number of hydraulic-rams or jacks, by the aid of which the whole apparatus can be pushed forward, so that the knife edge may be pressed into, and cut away a portion of, the clay in front. The cylindrical shell of the shield is usually fitted with a circular diaphragm, shewn by the general view in Fig. 6, so that a timber bulkhead may be formed, if necessary, for the purpose of excluding water from the workings. Fig. 7 gives details of a 12 ft. 8 in. shield, and may help to make clear the method of operation, which is as follows:—After the shield has

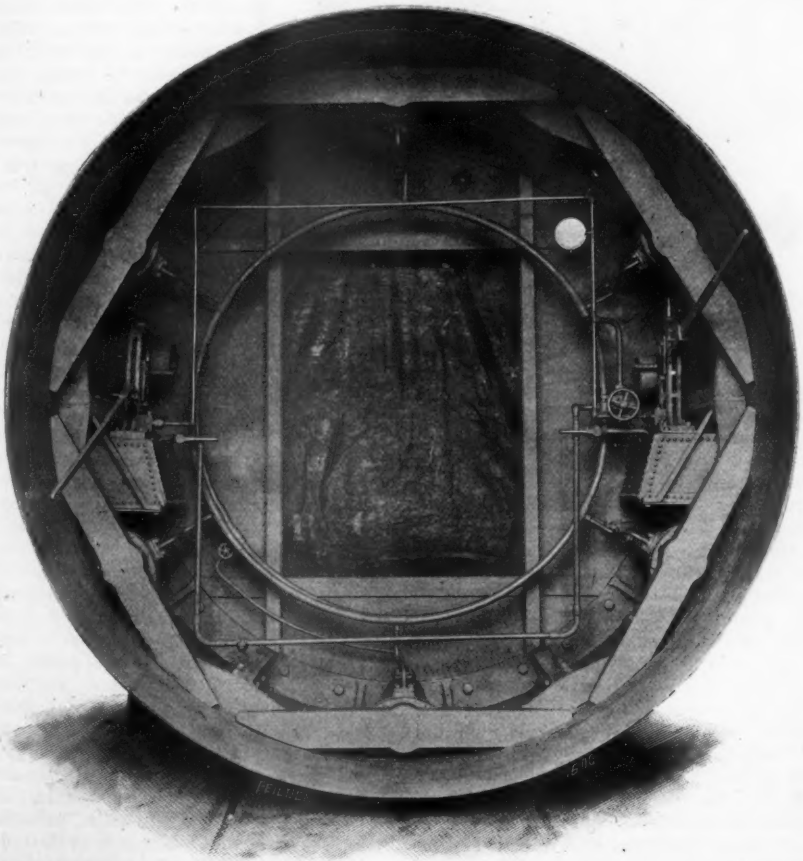


FIG. 10.—REAR ELEVATION OF A SHIELD FOR 10 FT. 6 IN. DIA. TUNNEL ON THE CITY AND SOUTH LONDON RAILWAY SHOWING HYDRAULIC CYLINDERS AND HAND PUMPS. (MAKERS, MESSRS. MARKHAM AND CO., CHESTERFIELD.)

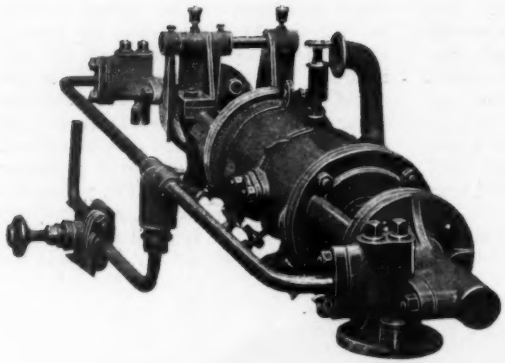


FIG. 11A.—C.L.R. AIR-DRIVEN HYDRAULIC PUMP FOR SMALL SHIELDS.

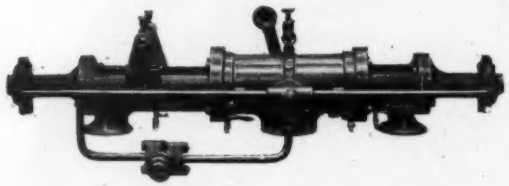


FIG. 11B.—ANOTHER VIEW OF SAME.

been placed in the correct position a ring of cast-iron segments, which are to form the interior lining of the tunnel, is built up inside the shield, whilst miners and their labourers attack the central part of the exposed clay surface. The excavated material is shovelled into skips, which are run along a temporary tram line laid from the shield to the bottom of the shaft. From thence the skips are wound up to the platform at the head of the shaft, where the clay is tipped out and carted away. Fig. 5 is reproduced from the photograph of an electrically driven locomotive used for the temporary track. This engine is of 25 h.p., 2 ft. gauge, built for the Central London Railway by Messrs. Ernest Scott and Mountain, Newcastle-on-Tyne. By the time the labourers have driven a short advance heading, about 6 sq. ft., in the centre of the clay wall, directly in front of the shield, the other part of the gang have completed the ring of cast-iron segments. The hydraulic-rams are then started and the shield is slowly pushed forward, its circular knife edge cutting the larger part of the annular face of clay cleanly away from the solid bed, and causing the upper portion to fall towards the central heading. The fallen and loosened material is then removed, and a similar cycle of operations is repeated. The ends of the rams actuating the shield are provided with steel cross-heads, bearing upon a timber ring placed at the front end of the segmental lining, or in the case of the first operation of the shield, the cross-heads press against a temporary bulkhead of timber, so that a forward movement of the shield may be ensured on the application of pressure. As the shield is about 2 ins. larger in diameter than the exterior of the lining of the tunnel, there is an annular space between the cast-iron cylinder and the newly-cut surface of the clay. This space is filled by a grouting of hydraulic lime and water, forced by compressed air through small holes cast in certain of the segments, and as soon as the lime has set, the iron tunnel is immovably fixed in the clay, and capable of withstanding any strain that is likely to be experienced.

Speaking generally, the tunnels for the up and down lines were driven from end to end by a Greathead shield, 12 ft. 8 ins. diameter, as illustrated in Fig. 7. Larger shields were used at some points on the railway. For instance, at some places where the curves are sharp, the running tunnels were constructed by the use of shields measuring 13 ft. 5 ins. and 13 ft. 7 ins. in diameter. Again, the station tunnels measure 21 ft., and the cross-over tunnels providing access from one set of metals to the other are 25 ft. in diameter. Although all the shields employed were of one general type, the details of construction differed

somewhat according to their size, and as we shall presently show, their auxiliary appliances were not the same on every section of the line. Each of the smaller sized shields has a cast-iron lining ring within the surrounding cylinder, and this ring carries six 7-in. diameter hydraulic rams, working at any required pressure up to 3,000 lbs. on the sq. in. The general mode of operation has already been described, but it may be well to mention that the erection of the cast-iron segments is accomplished entirely by hand labour, for as each casting only weighs about 6 cwt., the adoption of mechanical appliances has not been found to be necessary. Six of these plates are required for the formation of one ring, the circumferential joints being made by the aid of 53 bolts, and the circle is completed by the insertion of a key 10 ins. wide. The web of each plate, or segment, is $\frac{7}{8}$ in. thick, and the flanges through which the bolts pass are 4 ins. wide.

In the case of the larger shields, for tunnels 21 ft. 2½ ins. and 25 ft. in diameter, 22 hydraulic rams of 7 ins. diameter are provided, and a framework of steel girders is constructed within the periphery of the shield, serving the double purpose of stiffening the shield and of supporting a platform upon which the men work who are employed in cutting away the clay face. An advance heading is not driven, but the face is divided into seven compartments, in each of which two or more men can work. To prevent the large face of excavation from slipping as the work proceeds, an ingenious arrangement devised by Mr. Greathead is adopted. Horizontal and vertical cross-girders support four "face-rams," consisting of large cylinders and pistons, carrying steel girders in front. Fig. 8A is an elevation from the rear of a 25 ft. cross-over tunnel shield, showing hydraulic cylinders, face-rams, and one of the erectors mentioned above. Fig. 8B gives the vertical section, cutting-edge elevation and face-ram table plan of

ELECTRICALLY-DRIVEN HYDRAULIC PUMPS FOR STATION-SHIELDS.

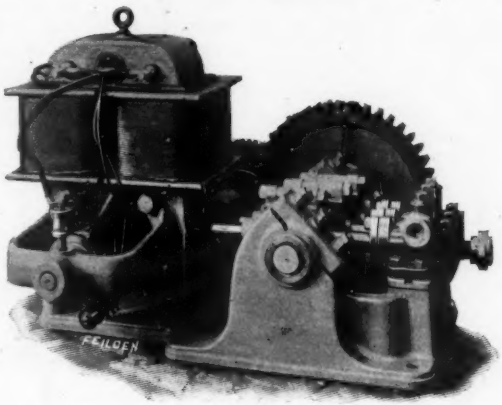


FIG. 12A.—HORIZONTAL 3-THROW PATTERN, SPUR-GEAR DRIVEN.

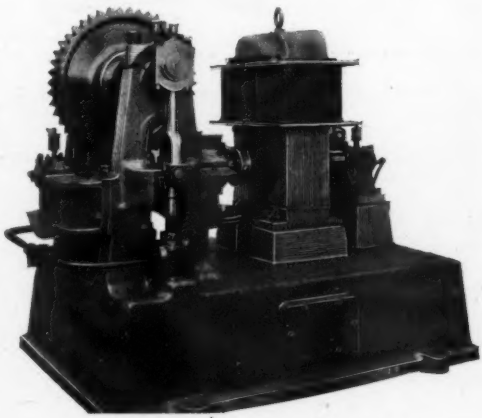


FIG. 12B.—VERTICAL 3-THROW PATTERN, WORM-DRIVEN.

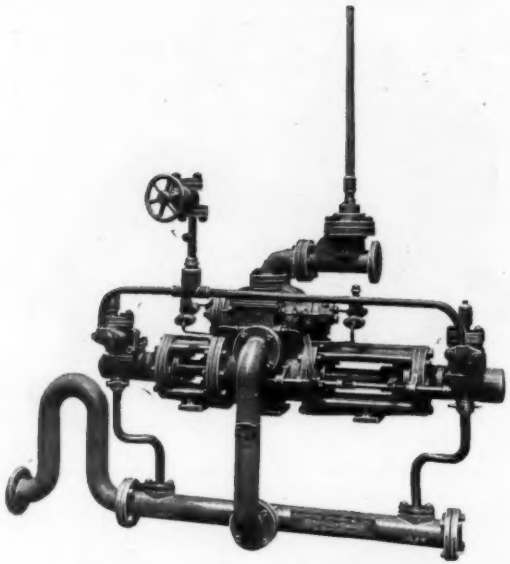


FIG. 13.—HYDRAULICALLY-DRIVEN WATER-PRESSURE PUMP FOR DRIVING AND ERECTING LINING.

the same shield. When the shield is ready to be pushed forward, the face-ram pistons are fully extended and subject to a uniform pressure of 700 lbs. per sq. in., governed by suitable relief-valves. As the shield moves ahead under the influence of the 22 rams before mentioned, the face-ram pistons are forced backward into their respective cylinders, still maintaining a uniform supporting pressure on the face of the clay by means of the steel girders. Consequently no slips are possible, and no timbering is necessary for the support of the face. Another deviation from the mode of procedure observed in the case of the small shields is necessitated by the greater weight of the cast-iron segments used for lining the larger tunnels, and by the greater height to which they have to be lifted. The weight of each segment varies from 9 cwt. upwards, and as they have to be lifted 20 ft. or more, the employment of mechanical appliances is essential. As shown in Fig. 8A, the segments are put up by the aid of an "erector," consisting of extending and radiating hydraulic rams, mounted on pivots. There are two erectors to each shield, one to the left and the other to the right. The segmental plate is secured to the lower end of the extension ram by a hooked jaw and cross-bar passing through the hole of the plate, and it is raised by the protrusion of the ram from the cylinder. The erector, with the plate attached, is then slewed bodily until the plate is brought to the desired position. It is extremely interesting to watch this apparatus at work, and the results obtained are in every way satisfactory.

Progress was materially aided in the case of the smaller shields by the application of an arrangement of air-driven hydraulic pumps. The arrangement in question, which it will be observed is attached to, and forms a part of the shield, is shown in elevation by Fig. 9, and pictorially by Fig. 6. All the tunnel machinery was driven by compressed air, at a pressure of from 80 to 100 lbs. per sq. in., and conveyed through pipes laid along the tunnels. The exhaust from the various compressed-air engines driving the machinery served the incidental though highly desirable purpose of effectually ventilating the workings. This method of driving the shield had the effect of largely increasing the quantity of work done daily by each shield. As originally arranged, the small shields were provided with hand-pumps, depicted in Fig. 10, and the operation of advancing the shield one step was a very tedious and laborious task for the men, generally taking 20 mins. and frequently occupying very much longer. As the same work was afterwards performed in about 5 mins. by the aid of the device, it is evident that a very large saving in time must have been effected. The air cylinder of

the pump is 7 ins. in diameter, the two hydraulic plungers are 1 in. in diameter, giving if necessary a pressure of fully two tons to the sq. in. on the rams, which, it may be remarked, are 7 ins. in diameter, and are enabled to exert pressure in a forward direction by using the completed end of the tunnel as an abutment. Figs. 11A and 11B are views of the 7 ins. by 1 in. by 7 ins. air-driven hydraulic pump, as used in the 11 ft. 8¼ ins., 12 ft. 5 ins. and 12 ft. 7 ins. tunnels of the Central London Railway. For the larger shields similar air-driven pumps 9 ins. by 1½ ins. were ultimately used, but before these were ready, electrically-driven hydraulic pumps were employed in connection with the station shields for driving and lining-erecting. Two patterns of these are shown in Figs. 12A and 12B, the former being of the horizontal three-throw type with spur-gear, and the latter of the vertical three-throw type with worm-gear. These pumps were designed and made by Messrs. Scott & Mountain, of Newcastle-on-Tyne, their power with a voltage of 200, being from 7 to 10 h.p. As our readers will probably anticipate, the insulation of the armature was strained somewhat severely in damp tunnels such as those on the Central London line, and moreover the expenditure of current was found to be abnormally heavy. Fig. 13 represents a hydraulically-driven water pressure pump for station or cross-over shield driven by a water service of 700 lbs. per square inch.

As the main running tunnels follow numerous curves and gradients, setting out below from 8 to 11 angles was necessitated in each separate section between the station shafts. The longest separate length driven was that from Westbourne to the Marble Arch, and it is a striking instance of the care exercised that in a distance of more than 1,200 yds., the amount of error was only ⅝ in. at the junction of work done by two contractors. In two of the sections bore-holes were put down into the tunnel for the purpose of checking the lines, but as a general rule the lengths

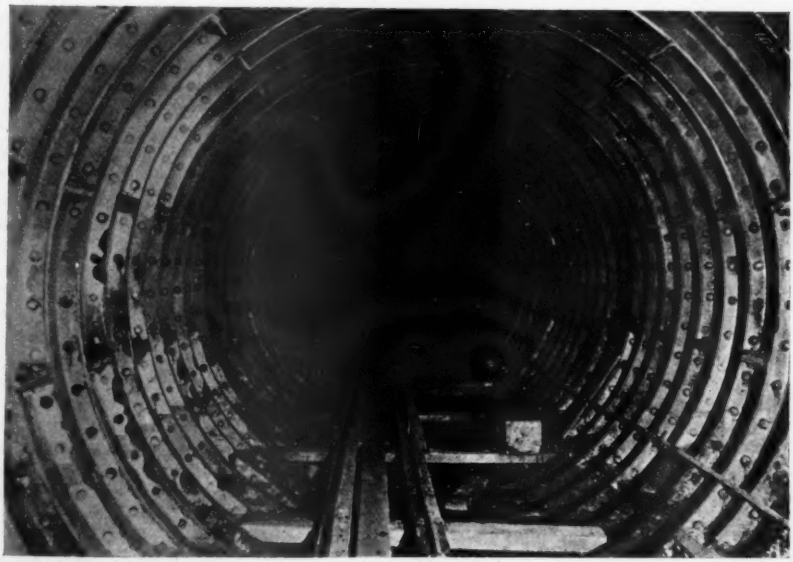


FIG. 14.—OPEN END 12 FT. 7 IN. TUNNEL AT SHEPHERD'S BUSH DEPOT. LOOKING DOWN THE 1 IN 40 DECLINE.

FIG. 15.—OUTSIDE OF AIRLOCK IN 12 FT. 7 IN. INCLINE TUNNEL TO SHEPHERD'S BUSH DEPOT.

were driven through correctly without recourse being made to test-borings. Even after the survey line had been actually fixed in the tunnels, constant attention was required at each of the several faces to keep the shields to the proper line of gradient, more particularly the smaller or running tunnels. The station or cross-over tunnel shields were comparatively easy to keep to the correct lines, because the number of rams proportionately to the diameter is much greater than in the small tunnels. Care must always be taken to see that the advance heading is driven fairly in the centre of the face, that the breaking-up piles attached to and forced by the shield into the face of the clay are evenly spaced, and that the margin of clay left for removal by the cutting edge of the shield is uniform all round so that equal resistance may be ensured. When very sharp curves, such as three to five chains radius have to be followed, it is advisable for the shield to be assisted by trimming away some of the clay round the cutting edge at the two sides. Unless some clearance is thus provided, the act of forcing the shield round the sharp curve may cause strains productive of serious injury to the apparatus. As a matter of fact, cases have been known in which the absence of clearance has been directly responsible for fracture of the castings to which the ram cylinders are fixed, for crippling of the tail-plates, as well as for deviation of the driving from the correct centre-line.

Daily observations were taken and recorded of the exact bearing of the shield and of the iron lining immediately behind it, so that the correct line and level might be followed. Daily written instructions were given to the man in charge at each face as to the "lead" of the shield, and relative to the packing to be used, either for line or level or for both as occasion demanded. Constant attention to this matter is most important, and it was found by the superintending engineers that the most satisfactory results were always obtained when assistants had been care-

fully trained to communicate, and foremen to follow, the daily directions issued.

Under the most favourable conditions, that is to say where air-motors were adopted for driving the pumps, the average rate of progress for the small shields was 40 rings, each 1 ft. 8 ins. long, or 70 ft., per week of 115 hrs., whilst the maximum progress in any one week was 50 rings, or 84 ft. The large shields progressed about 44 ft. per week. It may be interesting to note that the latter each weigh nearly 70 tons, and that on the completion of one station, or cross-over tunnel, the shield was taken down and conveyed to a fresh site, where it was re-erected in a special shield-chamber, from which the driving of the next tunnel was commenced. Altogether, 31 shields and 3,000 men were engaged in tunnelling operations. More than 500,000 cub. yds. of material have been excavated and carted away, whilst 100,000 tons of cast-iron segments and nearly 3,000 tons of bolts were used in lining the tunnels.

At the western end trains enter the railway by an inclined tunnel, see Fig. 14, starting at the Depôt. Fig. 15 is a view outside the air-lock used in passing through the gravel stratum overlying the London clay at the same section of the line. The peculiar effect observed in the lower portion of the photograph is not due to a fogged plate but to the emission of compressed air. Before the terminal passenger station is reached, a siding is passed with room for two trains parallel to the entrance tunnel; then comes a cross-over tunnel in which trains can be marshalled, and next to this are the two station tunnels. Beyond these is another cross-over tunnel, from which the main running tunnels start. Generally speaking, the locomotives are assisted in starting from the stations by downward gradients of 1 in 30, the total descent so caused being about 10 ft. Conversely, the motion of the train is retarded in approaching the stations by upward gradients of 1 in 60. Reference will be made at the proper place to the advantages secured by this arrangement. The up and down tunnels are generally side by side at the same, or nearly the same, level, but at Notting Hill Gate, Chancery Lane, and at the Post Office one tunnel is at a considerable distance above the other, in consequence of the narrowness of the roadways. At Shepherd's Bush, Queen's Road, and the Marble Arch there are two cross-over tunnels, with sidings of two train-lengths between the up and down lines. There are also two cross-over tunnels at the British Museum, and at the Bank.

(*To be continued.*)

W. H. Worthington

MACHINERY APPLIANCES AND PROCESSES.

"Every part and side of our life, from the cradle to the grave, has been touched and tended by the inventor and manufacturer. His works are as numberless as the sands of the sea, but the onward rush of Science and the Arts opens up new fields of discovery and enterprise as each day dawns. Let us choose here and there among thousands, and in choosing take the best as far as in us lies."

THE "STANDARD" DRIVING GEAR.

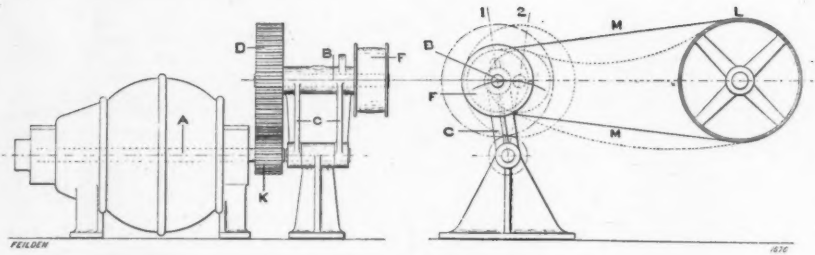
AFTER having determined the most suitable size of electro-motor to employ for driving any given mechanism, the general problem concerning the connecting gearing presents some few difficulties, amongst which may be mentioned (1) that of obtaining the requisite speed reduction by some compact and efficient form of gearing, (2) the provision of some ready method of allowing for considerable alterations in the ratio of the speed reduction, (3) a simple and durable device for throwing the motor out of gear.

When considering that it is necessary to design a gearing which, whilst fulfilling all the above conditions, must at the same time be capable of easy and expeditious application as the connecting link between the motor and the driven machine, it will be found that the problem is not so simple as may have been imagined. Reviewing some of the various methods which have been generally applied up to the present, it is found that those most commonly in use are belt, spur, worm, and some forms of friction gearing. The first of these, as a rule, does not permit of a compact arrangement, especially as the ratio of speed reduction is rarely less than 10 to 1; in fact, it is generally necessary to resort to a countershaft to avoid the use of comparatively large pulleys. The result is that the gearing becomes inefficient, chiefly owing to the fact that, whilst attempting to economise space, it has been found necessary to run the belts very tight, thereby introducing heavy pressures on the bearings of shafts rotating at high speeds. The maintenance of the belts at a proper degree of tension calls for that skill and attention which they rarely receive until a joint gives out or the belt becomes so slack as to be unable to do its work. It thus often happens that, if the belts are not putting injurious and wasteful pressure on the bearings, they are so slack as to slip on the pulleys.

The second method, that of direct or single reduction spur-gearing, is in very common use, especially for driving printing machinery. In this case, to obtain permanently satisfactory results, the motor must be directly and firmly attached to the frame of the machine in such a position as to cause the pinion to gear correctly with the spur wheel; and in the case of the heavier machines, it is generally advisable to interpose some form of friction-clutch for the purpose of enabling the motor to be started against a minimum resistance, and also for obviating that frequent stopping and starting of the motor at very short intervals, which when "making ready" is found necessary. This frequent stopping and starting of a motor under load is destructive to switch contacts and safety fuses.

The amount of trouble which can be experienced from this cause alone may perhaps be imagined after a perusal of the interesting paper contributed by Mr. C. A. L. Prussman at the late meeting of the Municipal Electrical Association. It has also been found, after an extended experience, that it is difficult to ensure the wheel teeth remaining always properly in gear, especially when the driven machine requires large and somewhat sudden variations in the driving effort. When starting a motor with a load on, or rigidly coupled to a machine whose moving parts have considerable inertia, the rush of current generally experienced is very undesirable from all points of view; it is especially undesirable in that it necessitates the use of such heavy safety fuses to carry these currents, that they often fail to protect the windings from the effects of a steady overload. The use of controllers can reduce this rush of current, but may and frequently does lead to a waste of "watts," and it is watt hours for which the consumer pays.

This spur-gearing is compact, when compared with the previously mentioned belt gearing, but it is often noisy even when a raw hide pinion is used, and the necessary



FIGS. 1 AND 2.—DETAILS OF "STANDARD" DRIVING GEAR.

spur wheel may be large and costly. It is, moreover, sometimes found that the spur-wheel will not run satisfactorily unless the shaft carrying it has been specially fitted with this end in view. There are, moreover, no facilities for speed variations, excepting through the means of introducing resistances in the motor circuits. If these resistances be inserted in the armature circuit, then the combined efficiency of the motor and controller is very poor, and may easily become as low as 40 or even 30 per cent.

On the other hand, if the speeds be varied by altering the strength of the field magnets, then, unfortunately, as the speed increases the available torque on the motor spindle decreases, which is just contrary to requirements, and leads to unnecessary expense on motor account.

Worm-gearing is subject to most of the disadvantages pertaining to the above-mentioned spur-gearing, excepting that it may be somewhat more compact, but the efficiency is comparatively low even at its best, and that is only attained as a result of a costly construction.

Finally, various designs of friction-gearing have been produced, but perhaps a really efficient arrangement thereof is more expensive than any of the already mentioned systems.

The "Standard" driving gear, as illustrated herewith in some of its applications, has been designed specially for use with electromotors, and not only is it suitable for working with continuous current but it is specially valuable in conjunction with alternating current motors, because of the ease with which a great ratio of speed reduction may be attained, and also of the promptitude with which the load may be thrown on or off.

The fundamental principle on which this system of gear works is a combination of

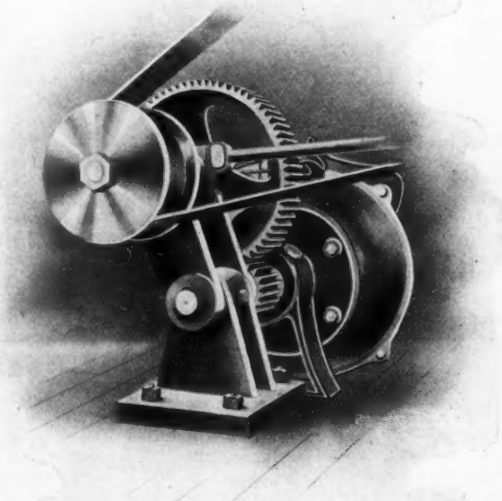
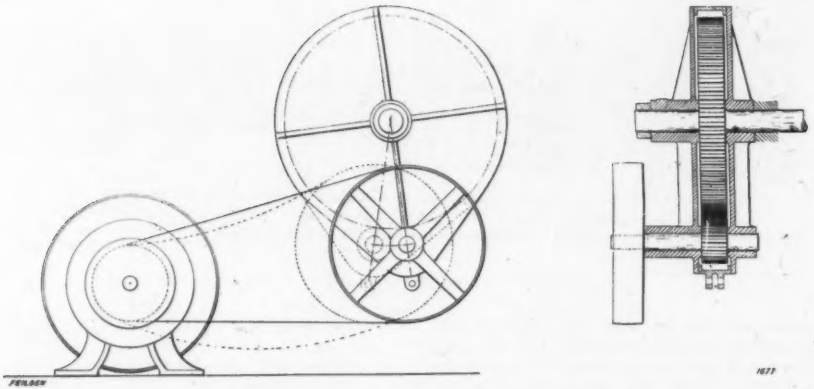


FIG. 3.—SHOWING PORTION OF "STANDARD" DRIVING GEAR.



FIGS. 4 AND 5.—"STANDARD" DRIVING GEAR SLIGHTLY MODIFIED.

belt and spur-gearing, and may, with the help of Figs. 1 and 2 be described as follows.

Two rotating shafts, *A* and *B*, are geared together by spur-wheels, and connected by a bracket *C* which can swing about the axis of one of the shafts whilst carrying with it the free shaft to which is attached a belt-pulley. The swinging motion thus obtained without disturbing the proper meshing of the spur-gear, enables the driving-belt to be tightened or slackened, thereby throwing the mechanism in and out of gear and causing the machine to be started or stopped without shock.

Referring again to Figs. 1 and 2, which show views of the gear in conjunction with an electric motor, the swinging bracket *C* can be distinguished in its position carrying the spindle *B*, on which is keyed the spur-wheel *D*, gearing with the pinion *K* on the motor spindle. It will thus be readily understood that no matter into what position the bracket *C* is swung, the wheel *D* and the pinion *K* remain correctly in gear. The spindle *B* carries a pulley *F*, which is connected by means of a belt *MM* with the pulley *L* of the driven machine. As one result of the ease with which the belt can be brought to the proper tension, it has been found that very short belts can be just as effective as long ones, providing the ratio of the diameters of the pulleys *F* and *L* is not great, which need never occur when this form of gearing is used.

The movements of the bracket being controlled by any convenient devices, and may thereby be partly rotated about the axis of the motor spindle, with the result that in some position of the bracket as shown by the full lines the belt is taut and the machine is driven; whilst, on the other hand, with the bracket in the position indicated by the dotted lines, the belt is slack and the machine is at rest. In this latter position the motor has only to turn the spindle *B* against its own friction and the friction of the belt on the pulley, the total resistance being so small that the power absorbed cannot be detected on ordinary instruments.

The gearing ratio may be varied by using pulleys of various diameters in place of the pulley *F*, the exchange being effected with ease and rapidity, as no alteration is required to the length of the belt.

Fig. 3 shows a reproduction of a photograph of one portion of the gear as actually constructed, the parts of which are readily distinguishable, and which are of such a nature that they can be manufactured and stocked in standard sizes, ready for prompt application to any motor or to any machine. This conduces to a considerable saving in the first cost, and generally obviates much loss of working time whilst the electro-motor and gearing are being installed.

Figs. 4 and 5 illustrate an instance in which the arrangement of the parts is slightly modified, the bracket swinging round the axis of the driven shaft and being carried by that shaft. Instead of a spur-pinion the motor carries a belt-pulley as shown.

Fig. 6 shows the standard gearing as arranged for driving a line-shaft in a factory by means of an electro-motor, *A*, whose pulley is belted direct to the pulley *B*. The line-shaft is shown in section at *C*, and the gearing between the pulley *B* and line-shaft is arranged exactly as shown in Fig. 5. By

means of the hand-wheel *D* and the worm and quadrant *E*, which raises or lowers the upper belt-pulley, the load may be transferred to or from the electro-motor ; and the belt can always be brought to a correct working tension, the motor being bolted to the foundation without employing any slide rails.

By means of these simple arrangements of gearing the whole of the requirements already enumerated are efficiently complied with, and that without necessitating any work being done to the motor or to the driven machine. The gear is manufactured by the Power Transmission & Traction Co., York.

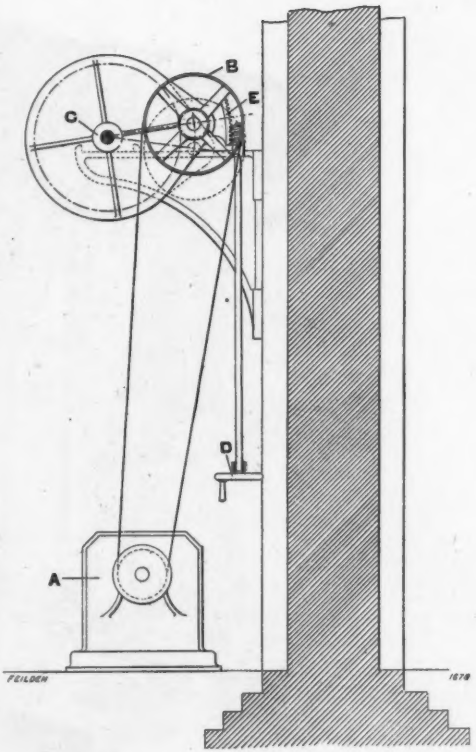


FIG. 6.—"STANDARD" GEAR AS ARRANGED FOR DRIVING A LINE-SHAFT IN A FACTORY BY A MOTOR.

AN ELECTRICALLY-DRIVEN HOT-SAW.

THE illustration on page 438 represents an electrically-driven hot-saw made by Messrs. Henry Berry & Co., Ltd., Leeds. This machine has been designed for cutting into lengths hot steel or iron bars of any section as they come from the rolling mill. Hitherto steam-driven machines of this class have been in vogue entailing, by reason of the distance between the actual machine and the boiler, excessive losses of steam in the pipes by condensation.

As will be seen, the saw is driven by twin-motors of the enclosed type, placed one on top of each standard and connected together by a short shaft carrying the driving pulleys. The standards are very massive, and are bound firmly together to avoid vibration, and are mounted on a massive cast-iron base of box section having provision for incorporation with the live roller rack, by which means it is possible to get a live roller close up on either side of the saw—a very useful feature when dealing with short lengths.

In other respects the saw is similar to the usual steam-driven ones. The swinging frame carrying the saw and spindle is in one piece of cast-iron, and arranged to be operated by hydraulic power.

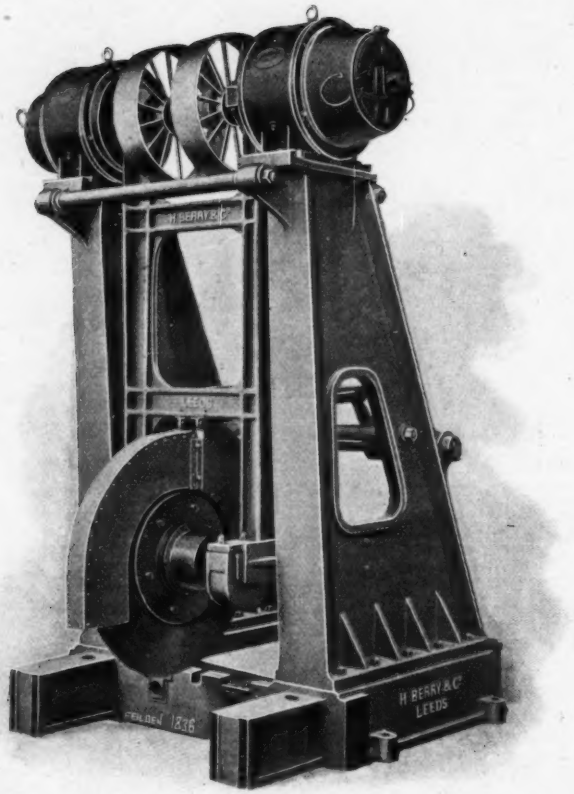
These saws can be made of any diameter and power.

AN ARTIFICIAL STONE FLAG PRESS.

THE illustration on page 439 represents one of Messrs. Henry Berry & Co.'s new Patent Presses for making artificial stone flags or paving. These presses have been designed with a view of getting a considerably increased output from each machine with a corresponding decrease in the cost of production.

The process of the manufacture of these flags, apart from the production of the slurry, involves four distinct operations, which are as follows :—

Preparing the mould to receive the slurry, filling the mould, applying the pressure to get rid of the water contained in the slurry, and, lastly, extracting the pressed flag from



ELECTRICALLY-DRIVEN HOT-SAW.

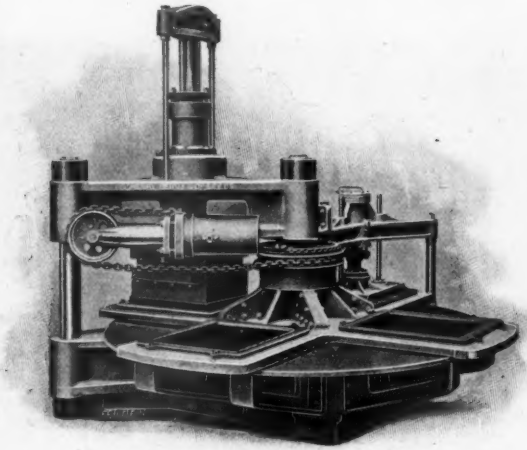
the mould previous to being conveyed to the drying shed.

It has hitherto been customary to make these tools with two moulds only, which could be placed alternately under the pressing cylinder, one mould being prepared and filled with the slurry whilst pressure is being applied to the other one, and the pressed flag afterwards extracted from the mould whilst still under the pressing cylinders.

The performance of this dual operation under the pressing cylinder caused a serious delay, as during the time occupied in getting the flag out of the mould, another one might have been pressed. In the machine under notice this delay is obviated, as all four operations are carried on simultaneously.

As will be seen from the illustration, four moulds are employed, to which a rotary motion is given instead of a reciprocating one, thus whilst one mould is being prepared to receive the slurry the next one is being filled, the third is having pressure applied, and the fourth is having the pressed flag extracted. As each operation is completed, the turntable carrying the moulds is caused to move through one-fourth of a revolution, and the cycle of operations is completed each time the turntable makes a complete revolution, during which time four flags will have been produced.

These presses are capable of being adapted to any required power, according to the size of the flag it is required to produce, and are supplied with the necessary hydraulic installation, comprising pumping engines, accumulator, and intensifier.



ARTIFICIAL STONE FLAG PRESS.

TWIN-SCREW CABLE STEAMER "JOHN PENDER."

THERE was recently launched at the shipbuilding yard of Messrs. R. Napier & Sons, Ltd., Glasgow, a steel twin-screw cable steamer of about 2,500 tons, built for the Eastern Telegraph Company, London.

The *John Pender* is the sixth cable steamer Messrs. Napier have constructed for this company, but it is much larger than any of its predecessors, and it is the finest and fastest boat in the fleet.

The general dimensions are :—Length, 317 ft. ; breadth, 41 ft. ; moulded depth, 26 ft. 8 ins., with a gross tonnage of 2,335 tons. She is built of steel to class 100 A1 at Lloyd's under special survey, and was completed in accordance with the Board of Trade regulations.

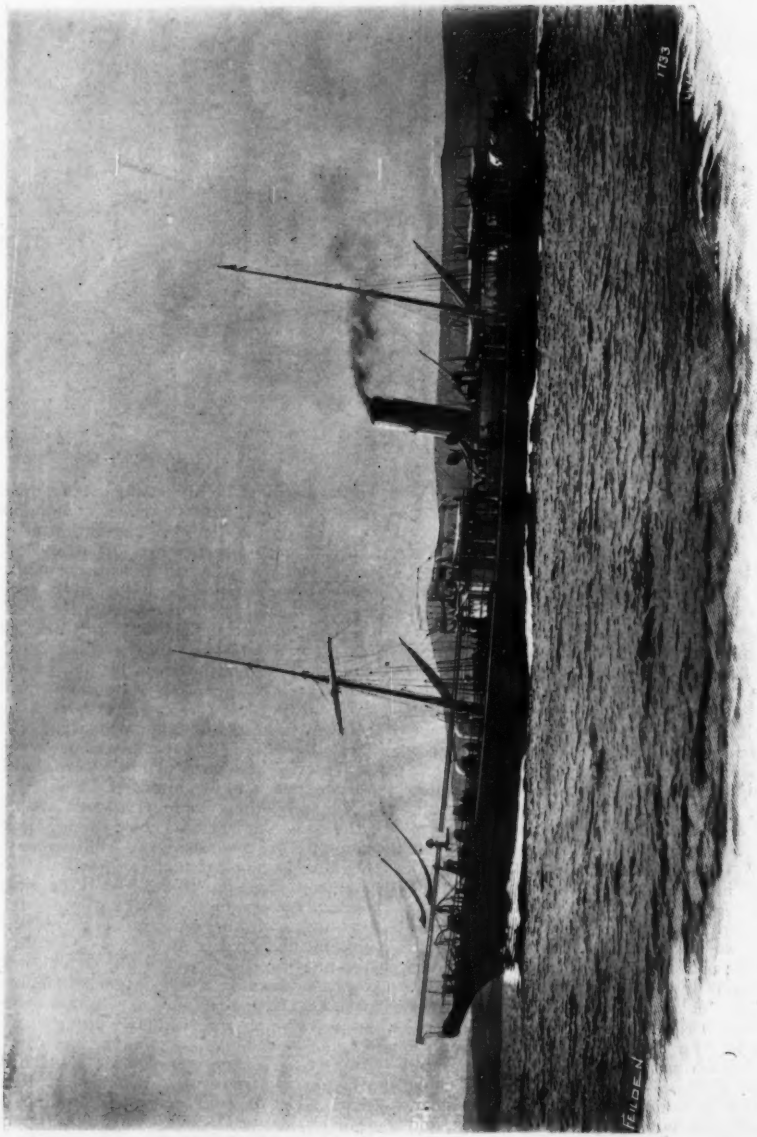
The upper deck is flush all fore and aft, to obtain an unobstructed lead from the five cable tanks to the picking-up and paying-out gear and to the bow and stern sheaves. The spar deck and fittings are of teak, and the most modern appliances have been provided for the difficult and delicate service of laying and repairing submarine telegraph cables. These include the steam cable machine, dynamometers, turning-over gear, sounding machine, powerful searchlight, and a very complete installation of electric lighting with duplicate dynamos.

Amidships is a very large chart house, captain's cabin, and testing room, while abaft the engines there is commodious accommodation for the captain, principal officers, and electricians, consisting of a handsome dining saloon in wainscot oak and spacious state-rooms, with the most recent improvements for the comforts of the staff.

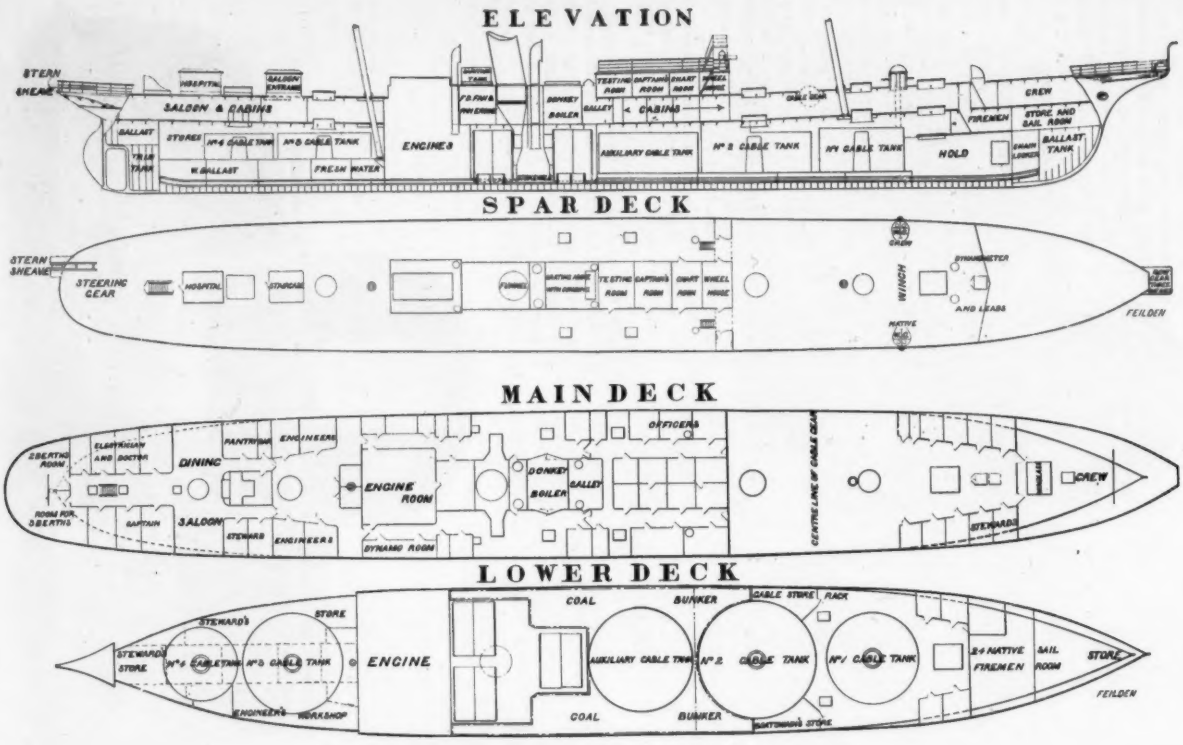
The engineers' quarters are near the machinery, and the petty officers, cable hands, crew, and firemen further forward. There are also numerous state-rooms for the cable plant, a large engineers' workshop, refrigerating room, dynamo space, and, in fact, everything that experience could suggest for the particular service on which the steamer is to be employed.

The propelling machinery, which was built at Messrs. Napier's Lancefield Engine Works, consists of two sets of triple-expansion engines, having cylinders 22, 35 and 58½ ins. diameter by 3-ft. stroke, and three single-ended boilers for a working pressure of 175 lbs., with the most modern appliances for efficiency and economy.

The propellers are of the navy bronze type, supplied by Messrs. Stone, of Deptford, who also furnished the water-tight doors and a portion of the sanitary fittings. The engine and boiler equipment consists of two 12-ton evaporators by Messrs. Caird & Raynor, a feed-water heater by Messrs. Kirkcaldy & Co., centrifugal pumps by Messrs. Drysdale & Co., main feed pumps by Messrs. G. & J. Weir, each pump having the full capacity of the boilers. The boilers are supplied with air by Howden's forced



CABLE STEAMER "JOHN PENDER," BUILT BY R. NAPIER & SONS, LTD., GLASGOW.



ELEVATION AND DECK PLANS OF THE CABLE STEAMER "JOHN PENDER.

draught, worked by a 90-in. fan, and two compound high-pressure auxiliary engines. The electric lighting of the ship has been carried out by Messrs. Clarke, Chapman & Co., of Gateshead. The set consists of two continuous-current dynamos, each with its separate direct-connected vertical steam engine. Each set has a capacity of 250 lights. The searchlight was also supplied by the same firm.

The engines for the cable gear were built by Messrs. Robey & Co., Lincoln.

Having been built with a cut-water stem and graceful lines, the new steamer is a very handsome craft, and with her smart rig looks like a large steam yacht.

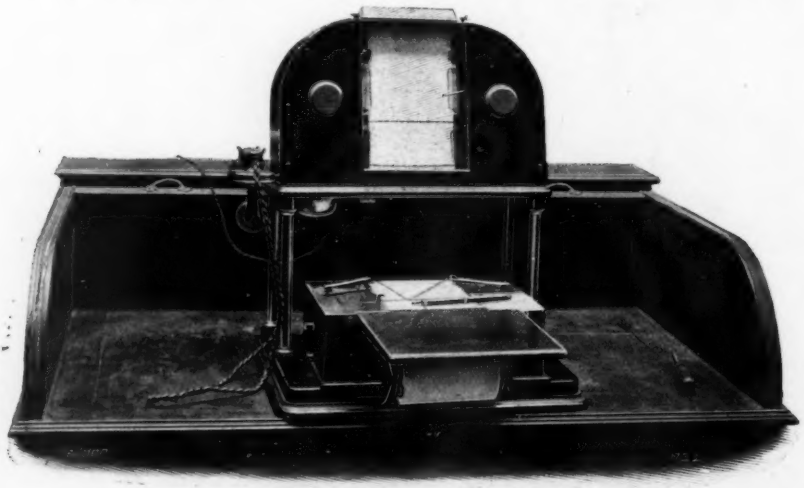
The official trials, which took place on the Clyde, were very satisfactory, the stipulated horse-power having been largely exceeded, the maximum speed easily attained, and the other conditions of the contract fully carried out.

We are indebted to Messrs. Napier & Sons, Ltd., for the photograph, and to The Eastern Telegraph Company for permission to reproduce the drawings.

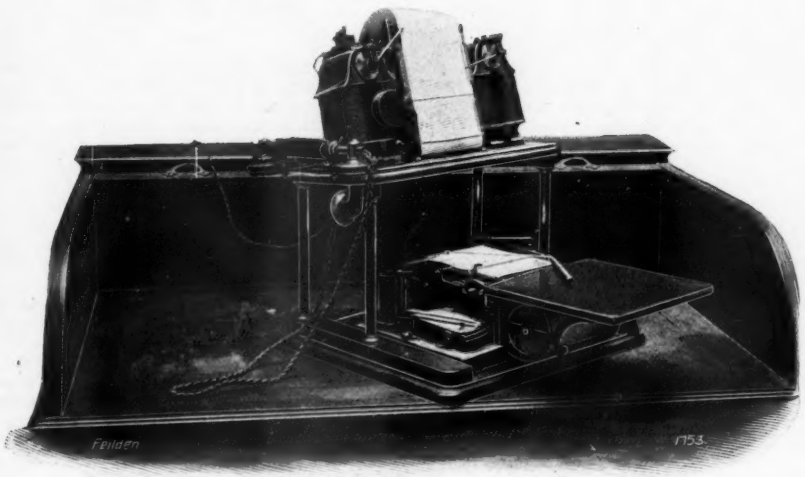
THE TELAUTOGRAPH.

A MEMBER of the staff of FEILDEN'S MAGAZINE recently paid a visit to the offices of the British Telautograph Company, 97, Gresham Street, E.C., with the object of inspecting the new apparatus invented by Mr. Foster Ritchie, by which the actual handwriting of an individual can be reproduced at a distance by electrical means. The advantages of a writing telegraph were recognised years ago, and many have been the attempts made to produce an instrument capable of transmitting and receiving such messages.

In the earlier forms the message was received on a chemically prepared paper, necessarily kept moist that it should form a conductor. The current passed through this paper from the receiving pen, causing its motions to be recorded by the discoloration of the paper due to the passage of such current. This record, however, unless again chemically heated, was not permanent, lasting only a few hours. Later on a machine was invented by Cowper, which produced the message in ink on a moving tape. While this had the advantage of producing a permanent record, the motions recorded were the resultant of those made by the writer's pencil and the moving tape, thus making it practically impossible for the message to be received in the writer's own handwriting. This system also had other objections, *i.e.*, all words and figures were connected; writing once done, was beyond the control of the sender for purposes of correction, dotting of i's, and crossing of t's. Drawings or sketches could not be sent, and considerable practice was required to produce intelligible writing. It had, in fact, few, if any, advantages over an ordinary Electric Printer.



THE TELAUTOGRAPH: INSTRUMENT READY TO BE OPERATED.



THE TELAUTOGRAPH: COVERS REMOVED.

Following Cowper came Prof. Elisha Gray, with an instrument that overcame nearly all of these objections, which he appropriately called the "Telautograph." The principle on which this machine worked was entirely new and original in Electrical Recording Apparatus. The sender, in moving a pencil (with which the transmitted copy was made), caused electrical impulses to be sent to the lines every one-hundredth of an inch of its motion. These impulses, at the receiver end, released an escapement, allowing a stored power to propel the receiving pen a similar distance, causing thereby a step by step motion like that of a second-hand of a clock. In rapid writing these impulses attain a very high rate, as many as 40,000 having been sent and recorded in a minute. Herein lay the necessity of delicate mechanism, for if one of these impulses be lost, the failure is recorded by imperfection or distortion of the received message. This instrument was a beautiful example of the possibilities of electrical mechanism, involving several exceedingly clever and new motions, but was found to be too complicated for continuous practical work.

In the latest and most up-to-date form of telautograph the above-mentioned objections and faults are largely overcome and the machine is much more simple, reliable, and inexpensive to manufacture, and, moreover, capable of working at any speed over any ordinary metallic telephone circuit.

The writing is done on a roll of paper 5 ins. wide, with an ordinary pencil, the movements of which cause variations in the strength of current or energy that is sent through the line wires. These varying forces cause the receiving pen to take up motions as imparted to the pencil, but only those are recorded at the receiver that are made on the paper at the transmitter, those made off the paper while being reproduced are not recorded. This makes corrections, drawings, shorthand, and in fact any and all kinds of messages quite within the power of the machine. The received message is written in ink upon a similar roll of paper, which can be readily cut off (a paper-cutter being attached to the instrument), and forms a permanent record. The transmitted copy can be also detached, and both filed for future reference. The receiver being entirely automatic in its action, messages are received without the necessity of anyone being present.

The main object of our representative's call was to gather information sufficient to lay before our readers a detailed technical description of the machine, but owing to the fact that patents for details have not yet been completed abroad Mr. Foster Ritchie was unable to allow us to do more than photograph the instrument as it appears

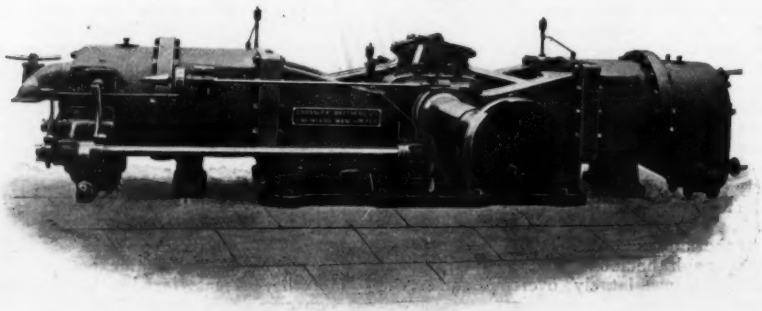
ready for operation, and with the working parts exposed, and to present the following information, which will serve to convey some idea as to the principle of working. If an earth return be employed two line wires are necessary between the receiving and transmitting stations. The current in each wire is varied by means of a rheostat, which is in series with the line wire and battery. A commutator, in the form of a quadrant, split up into small and numerous laminated sections (visible in the left-hand bottom corner of the illustration on page 443), is connected at frequent intervals with the resistance of the rheostat, a fine brush supplying the means of connection between the line wire and the commutator. The pencil used for writing the message to be transmitted fits into a socket, which is connected with levers, by which means the position of the brushes is altered on the commutators, thus determining the current in the wire with which it is connected. The position of the brushes again determines, through the current of the line wire, the position of the needle of a receiving galvanometer, which constitutes the recording apparatus at the receiving end, the motion of the pencil being exactly reproduced by a lever arrangement connected with the galvanometer. A recording pen is attached, which traces out the message on paper.

We understand the company has secured a license from the Postmaster-General to use the machines on private lines owned by the Post Office, and actual tests have been made by the British postal authorities in conjunction with the French postal authorities between London and Paris sufficient to have established the applicability of the system to long circuits.

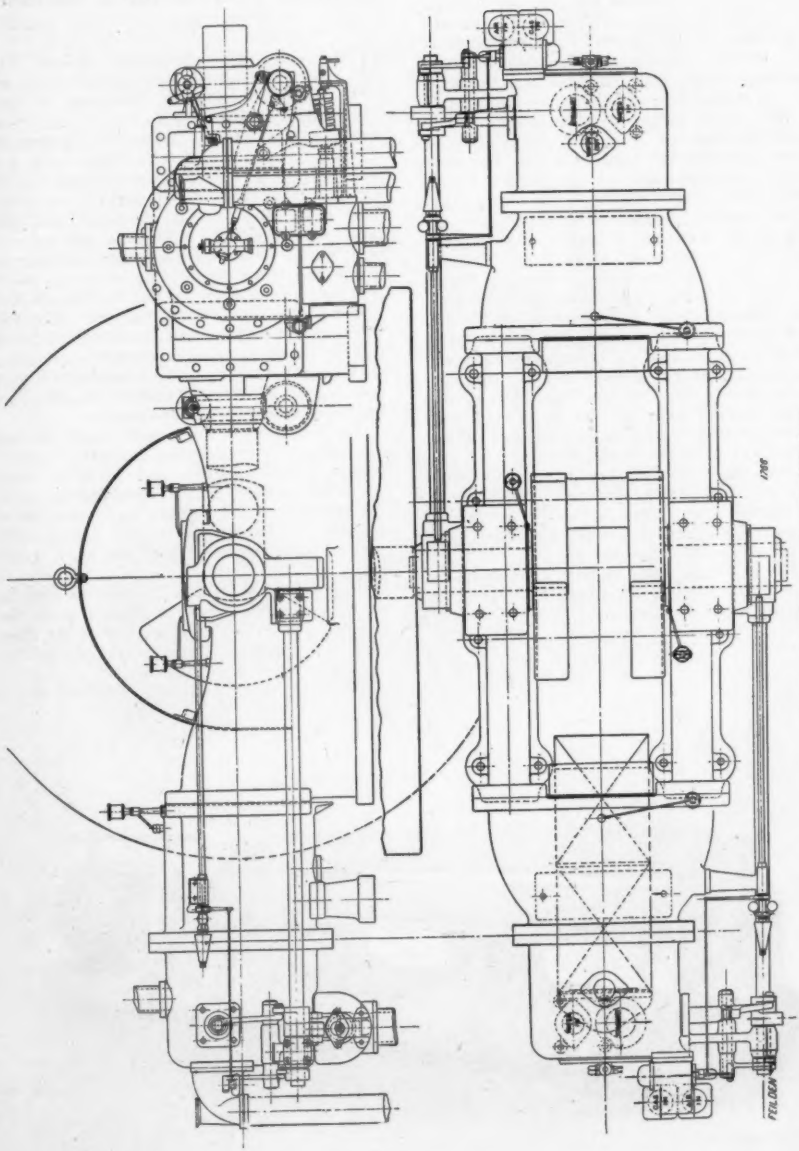
350-H.P. GAS ENGINE.

THE engine forming the subject of this notice is capable of developing 350 h.p., and is the largest ever turned out by Messrs. Crossley Bros., Ltd., Manchester. The features possessed by the engine are of a decidedly interesting character. The two cylinders, whose dimensions are 26 ins. diameter by 36 ins. stroke are placed opposite to one another on either side of the crank-shaft, both connecting rods being coupled to the same crank-pin, one rod having a forked end.

The engine is designed for driving a dynamo direct, the attachment being made by means of a flexible coupling. A heavy fly-wheel, 13 ft. diameter by 37 ins. wide, is fitted. This is made in two halves, which were joined together by a method which maintains the strength of the rim section throughout the joint, a very important point in connection with a heavy fly-wheel having a high peripheral speed. Dovetailed clips, carefully machined to a definite taper, are driven on to machined joggles. The ends of the clips are also fitted to undercut surfaces, which prevents any springing taking place. The clips are not machined externally until they have been fitted into position, when they are turned up with the fly-wheel itself. In the fly-wheel of the engine these clips are only used externally, being connected internally with bolts; it would, however, have been possible to have used the clips internally as well. Satisfactory advantages are claimed for this system as against the old method of shrinking hoops on rough projecting bosses, as the difficulty in connection with estimation of the strain due to shrinkage, and the more or less imperfect fitting of the hoops, is eliminated.



350-H.P. GAS ENGINE, BY CROSSLEY BROS., LTD., MANCHESTER.



350-H.P. GAS ENGINE: ELEVATION AND PLAN.

A high-speed centrifugal governor is fitted to each cylinder, which regulates the charge of the gas and air. The gas charges are controlled by the governor, the volume of the charge remaining constant, and no working charge being cut out until the load on the engine falls to below half the normal.

The crank arms are fitted with heavy cast-iron balance weights, and sight-feed lubricators are fitted throughout. The ends of the cylinder water-jackets are fitted with detachable covers which enable the jackets to be readily cleared of any deposit. To enable the exhaust valves to be readily repaired or renewed should the occasion arise, they are fitted in removable boxes instead of being cast on to the cylinders. The exhaust valves and spindles are hollow, and have a constant supply of water circulating through them. The valves themselves are new in design, an equilibrating arrangement having been adopted, rendering the opening of the valves—which are of large size, corresponding to the large diameter of the cylinders—a very easy matter.

The engine is designed to work with producer gas, and the trials gave great satisfaction, the output of the dynamo being 2,250 ampères at 110 volts., which is equal to 331 electrical horse-power.

All bearings and cooling arrangements have received special attention, to enable lengthy runs to be made.

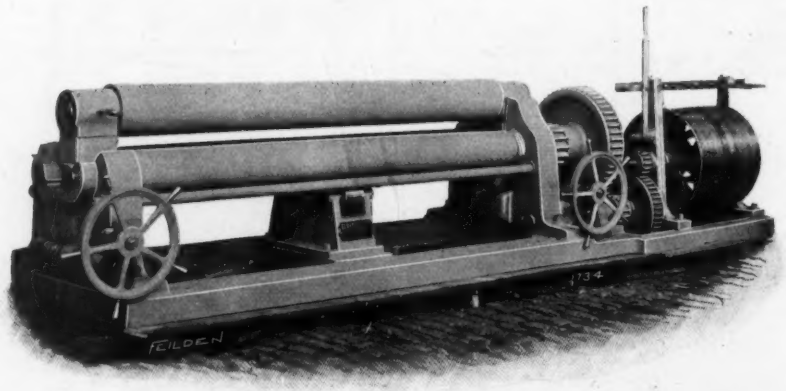
IMPROVED PLATE-BENDING MACHINE.

THE machine illustrated below has been designed and constructed by Mr. George Addy, Waverley Works, Sheffield, for bending plates up to 10 feet in width by $\frac{3}{4}$ in. thick. An unusual feature in such machines is that the three rolls are constructed of forged steel instead of, as hitherto has been the practice, cast iron. The top roll is 12 in. diameter and the bottom rolls 10 in. It may be pointed out that, with a view of avoiding any tendency to deflection, a strong casting carrying roller bearings is fixed under the centres of the bottom rolls to carry the weight. The top roll is raised and lowered by means of hand wheels, fitted to an arrangement consisting of worms and worm-wheels, connected to a steel screw of large diameter which gives the necessary vertical movement.

The machine is fitted with large driving pulleys, and is treble geared to afford ample power. Steel castings and forgings have been freely used in the manufacture, with the result that the rigidity and strength of the tool is more than ample, taking into consideration the nature of the work to be performed.

Everything is arranged to ensure ease in working, and the important point as to the height of the rolls with respect to the floor line when dealing with heavy plates has been accurately determined.

The total weight of the machine is 11 tons.



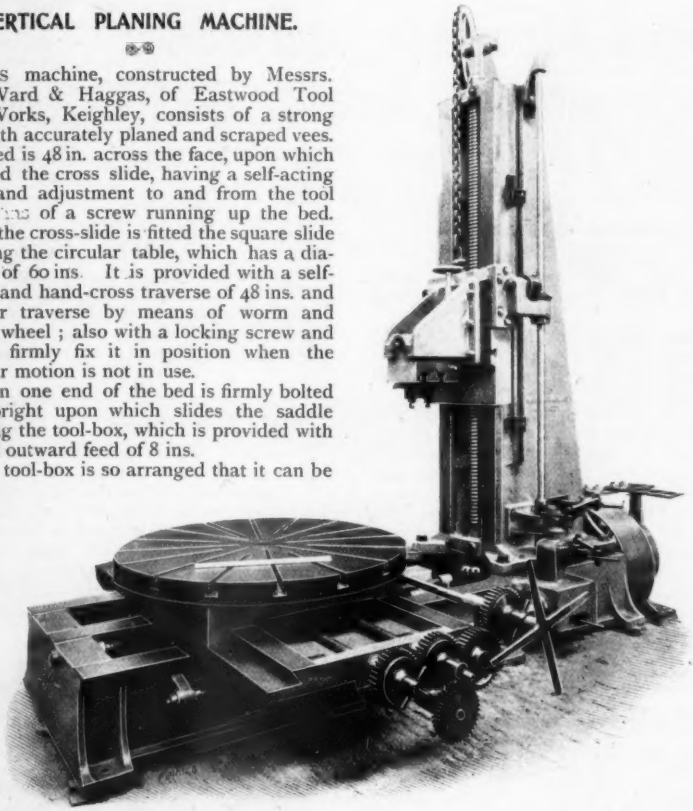
IMPROVED PLATE-BENDING MACHINE. G. ADDY, SHEFFIELD.

VERTICAL PLANING MACHINE.

THIS machine, constructed by Messrs. Ward & Haggas, of Eastwood Tool Works, Keighley, consists of a strong bed with accurately planed and scraped vees. The bed is 48 in. across the face, upon which is fitted the cross slide, having a self-acting and hand adjustment to and from the tool by means of a screw running up the bed. Upon the cross-slide is fitted the square slide carrying the circular table, which has a diameter of 60 ins. It is provided with a self-acting and hand-cross traverse of 48 ins. and circular traverse by means of worm and worm wheel ; also with a locking screw and die to firmly fix it in position when the circular motion is not in use.

Upon one end of the bed is firmly bolted the upright upon which slides the saddle carrying the tool-box, which is provided with a hand outward feed of 8 ins.

The tool-box is so arranged that it can be taken off, and a cross slide bolted in its place if so desired. The whole slide is balanced, the weight working down the side of the upright, so as to keep clear of the bolts and pulleys. The machine is driven by means of pulleys 36 ins. diameter by 4½ in. face, through bevel gear to a steel screw 4½ in. diameter, working in bronze parallel bearings, giving motion to the tool slide through a phosphor-bronze nut. The feed motion is arranged with a reversing gear to feed in either direction, all the feed wheels being of steel. The handles operating the slides, starting and stopping the machine, are grouped together within easy reach of the operator. The machine can be arranged with self-acting outward feed to tool-box if desired.



VERTICAL PLANING MACHINE. WARD AND HAGGAS, KEIGHLEY.

The Editor of FEILDEN'S MAGAZINE invites engineers and manufacturers to forward advance particulars, drawings, photographs, or any data which will enable him to publish a real and adequate description of any new machinery appliances, &c., or the installation of any plants possessing special features of interest, for the purpose of describing same in our literary columns.

Only such matter, however, as will enable us to present new and interesting information tending towards the advancement of the industries represented by the Magazine will be utilised, the Editor reserving to himself a freedom of judgment as to its value as news or technical matter. The costs of publication and engravings are borne by us, *no compensation* being expected.

In the endeavour to produce a really high-class and technically valuable machinery section in the Magazine the Editor seeks the co-operation of engineers and manufacturers.

Some Notable Exhibits at the Paris Exhibition.

(Continued from page 337.)

❀ ❀ ❀

BROWN & SHARPE CO.—*(continued).*

To their No. 2 Universal Milling Machine a more compact and stronger form of head-stock has been added, with an increased swing.

Automatic movements, longitudinal, vertical and transverse, are provided with automatic stops, which can be applied to the feeds at any point.

A very useful slotting attachment has also been devised, which is applicable to several of the milling machines. It is illustrated below in position, and its simple construction is its chief recommendation.

It is held in position from the overhanging arm of the machine, and further secured at the bottom by fixing to the vertical slide.

The tool slide of the slotting attachment is driven from the main spindle by an adjustable crank with a capacity up to 2 ins. This slide can be set at any angle up to 10 degs. on either side of the centre line, degrees being marked on the bottom of the slide-frame.

The tool-holder is arranged for tools with taper shanks of ½ in. diam., which are held in place by a clamp bolt, and further secured by a key which fits keyways in the tool-shanks, and ensures their relative position in duplicate work.

It will be of great advantage on work too small for an ordinary slotting machine.

As an example of fine and accurate division by the B. & S. Co. we were shown a very highly polished piece of metal, on the face of which was inscribed two concentric circles of about ⅞ ins. and ⅝ ins. diameter, the smaller of which had 100 equal divisions, whilst the larger was divided into 1,000, each line radiating to the centre. So fine were these lines that it was only possible to see them by the aid of a very powerful glass.

One other improvement may be noticed in the wheel-cutting machines of this firm. By an arrangement of gearing, the tangent wheel is slowed down as it approaches its next division, thereby obviating the tendency to carry it beyond its correct position by the acquired momentum of rapid revolution.

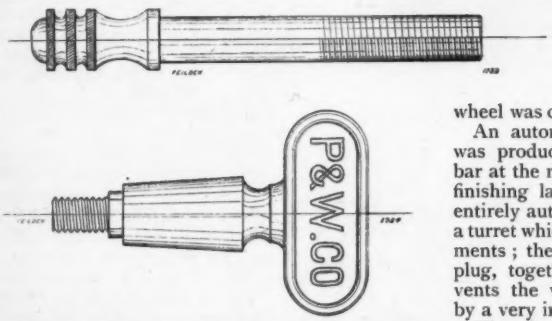
PRATT & WHITNEY CO.

THIS firm show some fine specimens of machine-tools, among which may be mentioned that for boring gun-barrels. Two bars of solid stock are placed parallel to each other, and are gripped in chucks and supported in stays, whilst being operated upon by twist drills having a single groove terminating in a cutting lip.

A continuous supply of oil is carried at a

BROWN AND SHARPE CO.—SLOTTING ATTACHMENT FOR MILLING MACHINE.

high pressure along a channel in the drill which communicates with the cutting nose, and on its return washes out the borings, thus preventing any tendency to gall or clog the cutter. A rifling machine, used in conjunction with the above, shows some very fine mechanical motions, all of which are automatic. The spindle in the head which holds the barrel is provided with a dividing arrangement, which gives it the proper position for the next cut to be made by the rifling rod. This portion of the machine is of a very complex nature, but can be easily arranged that different pitches or angles can be made to suit the rifling required, and by means of a transverse motion on a cross slide, the cutter is made to describe a true helix or screw which is mathematically proportioned to the bore of the barrel. The



PRATT AND WHITNEY CO.—KNURLED SCREW PRODUCED AT 45 PER HOUR BY AUTOMATIC SCREW MACHINE, AND PLUGS BEING OPERATED ON BY ENTIRELY AUTOMATIC BRASS-FINISHING LATHE.

rifling rod carries *one*, or in some cases *two*, cutters, which are expanded by means of a taper pin which is forced in the end of the bar, and strikes at the termination of each cut against a disc set on a small headstock.

By an automatic feeding device the disc is advanced proportionately, so that the pin is forced into the cutter just to the required distance ; as this is done at the end of the stroke it may be said that the cut is in reality a pull through the barrel.

A very powerful "parting off" machine is on exhibit, by means of which pieces of round bar iron may be cut off to a given length. A special feature of this machine is the arrangement of conical drums by which the speed of the bar and the advance of the cutter are increased as they near the termination of the cut, this being necessary in order to maintain the proper relation of speed and cut to a continually decreasing diameter.

Another excellent improvement is the support of the tool on the underside up to the finish of the cut by a following piece which is carried forward along with the tool, thus reducing the vibration attendant upon a large diameter and deep cut. As showing the efficiency of this machine, a piece of 3-in. bar iron was "parted off" in 4 mins.

Their automatic machinery for repetition work has evidently reached a high grade, as among it is a machine for the turning of sewing-machine hand-wheels or other similar work. The castings are placed in a hopper or slide, which is capable of holding about a dozen castings. These are fed automatically to the jaws of the chuck, where they are gripped and centred by a bar in the turret of the machine which coincides with some portion of the casting which sets it concentric ; it is then operated upon by a series of tools carried in a turret which has accommodation for five different forms.

A sewing-machine hand-wheel was completely finished in 4½ mins.

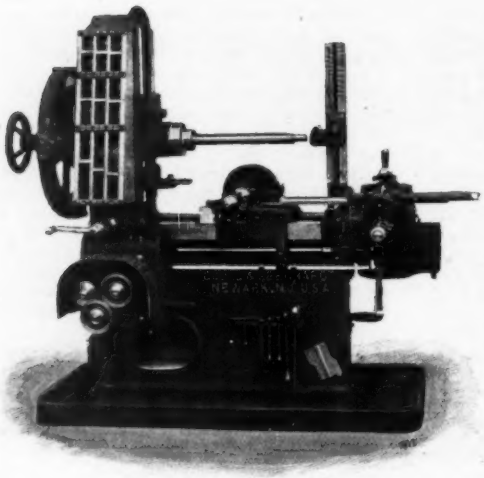
An automatic screw machine at work was producing knurled screws from the bar at the rate of 45 to 47 p. hr. A brass-finishing lathe operating on plugs is also entirely automatic. The tools are held in a turret which makes seven distinct movements ; the screw on the bottom of the plug, together with the flat which prevents the washer from turning, is made by a very ingenious device.

The time occupied for finishing the casting shown was 1¼ min.

A very heavy turret lathe was also at work on gear blanks. It is specially adapted to repetition work, the blank being operated upon by the turret tools, the roughing out being done with a flat tool relieved at intervals to reduce the vibration of the cut. A finishing tool similar to the first, but of the exact width and depth of the interior of the blank, completed the operation on one side, leaving the other to be reversed in the chuck and treated in the same way.

GOULD & EBERHARDT, U.S.A.

ONE of the principal exhibits of this firm is the "Victoria," a new type of gear cutting machine, which embodies many new features and some very valuable improvements, among which may be noted the dividing arrangement, whereby any number of teeth from 10 to 100, and all from 100 to 450 except the prime numbers,



GOULD AND EBERHARDT.—"VICTORIA" GEAR CUTTING MACHINE.

and their multiples may be cut without the aid of additional change wheels. The division wheel is completely encased, thus preventing the ingress of grit or any foreign substance tending to destroy the accuracy of the teeth; it is also made in two sections, and is claimed to be *positively correct*, and by a lever movement the worm can be engaged for working and disengaged for testing purposes.

It is also provided with a micrometer adjustment for the re-cutting of teeth if desired. Another decided improvement is seen in the vertical slide carrying the spindle on which is fixed the wheel-blank, this consists of a slide traversing the upright which is open right through and provided with a double V slide at the front of a lathe bed section, this gives stability and avoids the overhang of the slide as generally designed.

It is driven throughout by helical gearing, the easy running of which is ensured by a plentiful supply of oil.

A very essential point in the machine is one that prevents the feeding forward of the cutter slide, unless the divisions have been made complete, thus disposing of the liability of spoiling gear-blanks; as if by any means the several movements are incomplete the machine is at once thrown out of gear automatically.

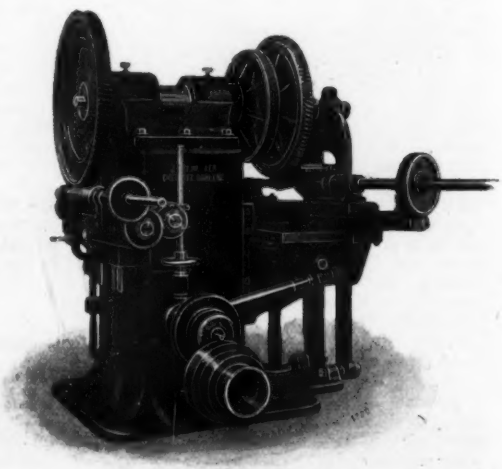
Spring pins are also inserted in the change wheel shafts, at once dispensing with collars or nuts.

A vertical upright is also provided to support the main spindle of the machine as shown in the illustration.

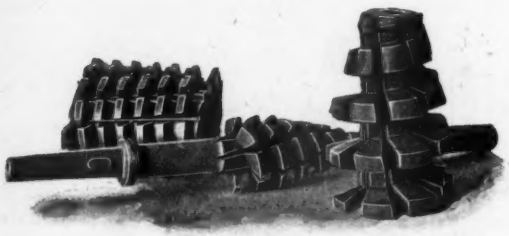
BULLARD MACHINE TOOL CO., U.S.A.

ANOTHER improvement has been introduced by these machinists on their turning mills by which a screw-cutting arrangement in the tool box enables the operator to cut a thread in any piece of work without removing the same from the table.

In concluding our remarks on the efficiency of American tools, we must not omit to state that in all the trials we saw, the metal, particularly the cast-iron, was of a much softer nature than the British products and consequently more easily workable.



J. REINECKER, CHEMNITZ.—UNIVERSAL WORM GEAR CUTTING MACHINE.



J. REINECKER, CHEMNITZ.—BACKED-OFF WORM-GEAR CUTTERS WITH SPIRAL GROOVES.

REINECKER, CHEMNITZ.

THE premier exhibit among Continental makers of machine tools is undoubtedly that of J. E. Reinecker, of Chemnitz, Germany, who employs upwards of 1,100 workmen. The works have been established about 35 years, and include in their turnout almost every kind of modern machine tool, each one of which is in some degree an improvement on its predecessor. Among the most recent may be quoted the Worm-Gear Cutting Machine, a side elevation and sectional elevation of which are shown on a succeeding page.

The object of this machine is to produce a *perfect worm-wheel* without having to contend with the many difficulties which are experienced in the production of these wheels on ordinary gear-cutting machines. This is accomplished by fixing the wheel-blank on a spindle carried through the head of the machine, and which is rotated by a master worm-wheel of a relative pitch to the one to be cut; this is driven by a worm supported in a horizontal slide, with provision for raising or lowering the same to any height necessary to gear with a smaller or larger master-wheel, and is entirely independent of the table, on which the hob-spindle is supported in movable bearings. The mechanism is made *absolutely positive*, so that the whole of the movements can be set and proportioned to each other, such as the relation between the master-wheel and the blank to be cut, and the transmission of proportional speed by the vertical shaft, driven by skew-gearing, which, in turn, transmits motion to the sliding table and cutter-bar by mitre gears and change wheels.

The periphery of the blank is then formed into teeth, by means of a taper hob or cutter which is set tangentially, and gradually attacks the blank until it has reached the full depth of the tooth.

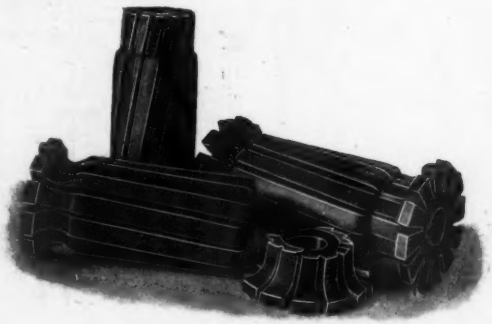
The advantage of this method is the reduction of any error, consequent upon the heating of a single rotary cutter.

Another feature is that the division of a given number of teeth is made by cut change wheels instead of the usual tangent wheel. The long worm which gears with the master wheel, at the back of the machine, is necessary for the purpose of the feed of the hob in unison with the rotation of the master wheel and the blank, thus disposing of a sliding head, as it is obvious if one of these arrangements were omitted the hob or cutter would simply go on reducing the blank in diameter instead of forming the teeth.

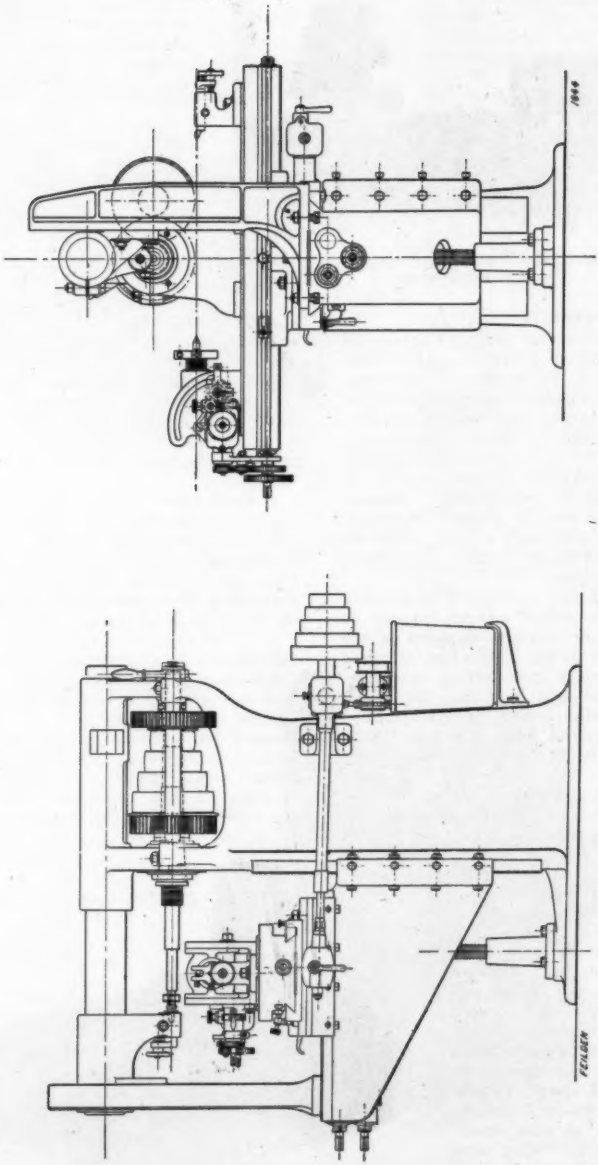
A small head is substituted when a small size master wheel is to be used.

Another important machine is one for *backing-off* milling cutters in a *spiral direction*—an operation never before attained—and which has entirely obviated the necessity of relieving form cutters in the old way, viz., by cutting away portions of the teeth alternately; by this method the whole of the cutting face is gradually brought in contac with the work, thus increasing the working surface of the cutter, with the further important characteristic of retaining its exact profile throughout. Examples of cutters backed-off spirally are shown above.

A special tool, which may be said to form the complement to the worm-wheel cutting

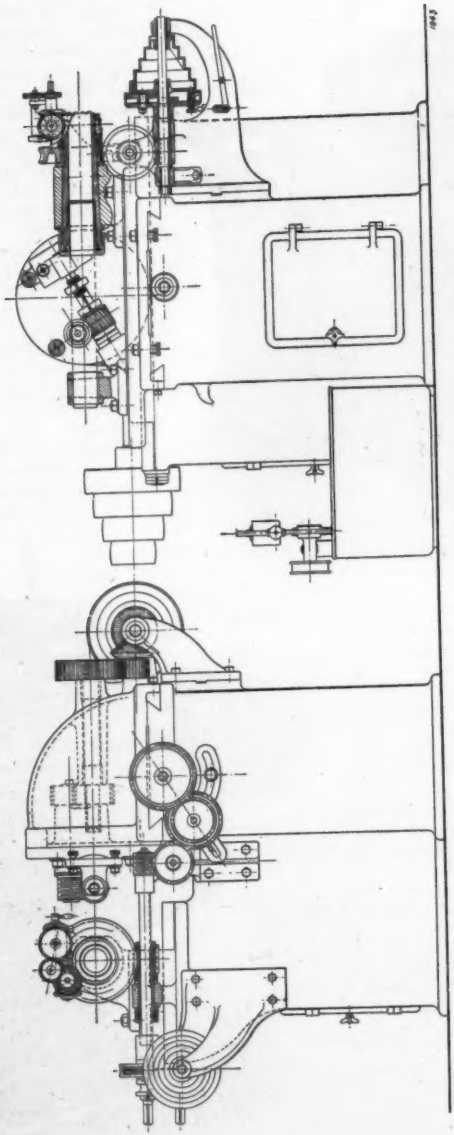


J. REINECKER, CHEMNITZ.—FORMED MILLING CUTTERS.

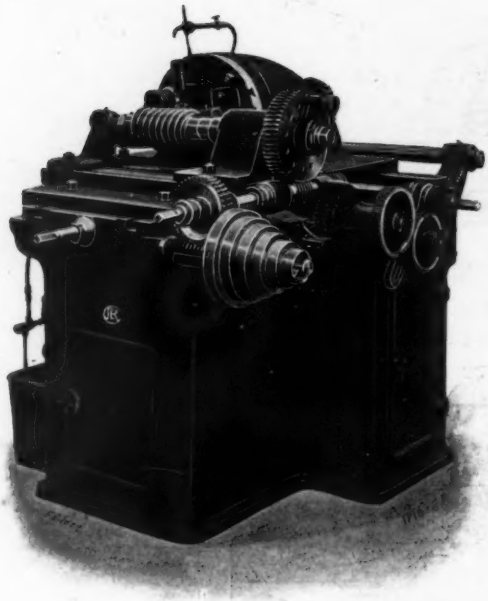


SECTIONAL ELEVATION.

SIDE ELEVATION. J. REINECKER, CHEMNITZ.—UNIVERSAL MILLING MACHINE



J. REINECKER, CHEMNITZ.—WORM-CUTTING MACHINE.



J. REINECKER, CHEMNITZ.—WORM-CUTTING MACHINE.

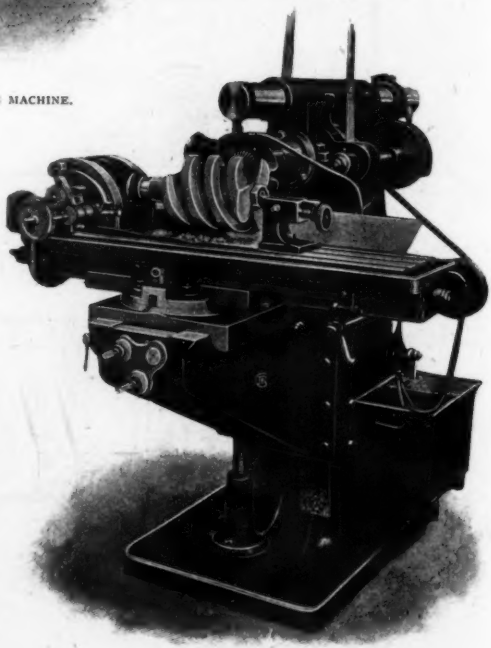
machine, and would be profitably used in connection with it, is the Worm-Cutting Machine. The work on which it is employed is similar to that of Messrs. Holroyd & Co.'s, but is different in construction and in its method of operation. It is provided with a movable graduated head, which carries on the face fixings supporting the cutter shaft, which is driven by skew-gearing. The centre line of the shaft exactly coincides with the centre line of the mandrel on which the worm-blanks are fixed, thus the head can be swivelled round to the necessary angle corresponding to that of the required helix, and by means of a dividing arrangement double, treble, or multiple threaded worms are produced.

A reference to the sectional elevations of the machine will clearly indicate the arrangement of gearing and the method of driving the milling cutter and rotating the worm mandrel.

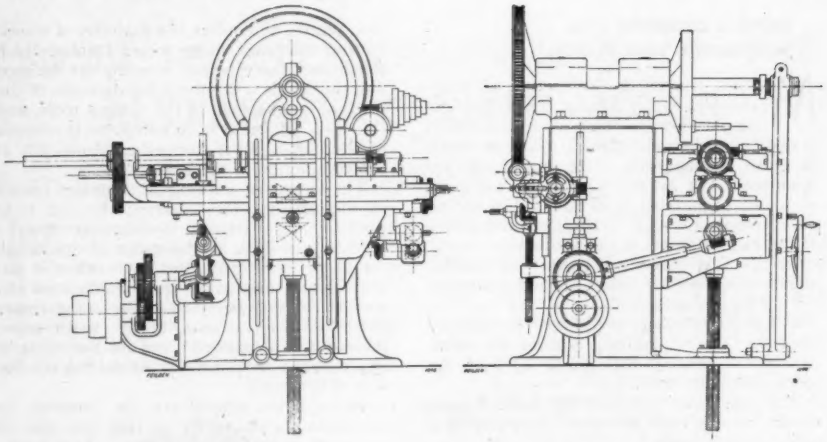
The No. 2 Universal Milling Machine shown at sectional elevations is a well-designed machine, with a capacity for dealing with any ordinary job in milling, twist-drill, gear cutting, etc., in addition to which it is provided with a movable head which can be fixed on the cutter-spindle, and is shown in the process of worm cutting on the full illustration.

By the courtesy of the gentlemen in charge of this exhibit, we were shown a very sensitive measuring machine, which may be briefly described as follows, and which has the merit of being put to practical use in the works.

On a short bed two heads are fixed, one of which terminates in a micrometer adjustment, the other having a stop directly connected with a flexible disc, which is influenced by the variation in measurement of any number of articles placed between the heads. By the rising of a fluid in a vertical



J. REINECKER, CHEMNITZ.—UNIVERSAL MILLING MACHINE.

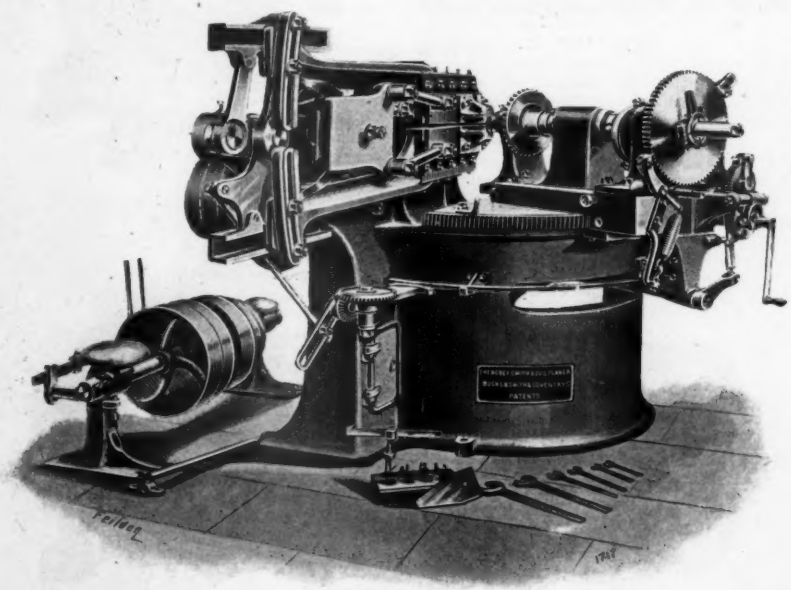


SECTIONAL ELEVATION. SIDE ELEVATION.

J. REINECKER, CHEMNITZ.—WORM-GEAR CUTTING MACHINE.

tube, on the same principle as a thermometer, it is possible to easily detect a variation of $\frac{1}{1000}$ of a millimetre.

The sensitiveness of the machine can be appreciated, as by the resting of the human finger for the space of a few seconds on a cylindrical piece of iron—previously measured with great exactitude—an expansion was caused which was indicated by a very perceptible rise in the recording tube.



SMITH AND COVENTRY, LTD.—PATENT BEVEL WHEEL PLANER.

SMITH & COVENTRY, LTD., MANCHESTER, GEAR PLANER.

MESSRS. SMITH & COVENTRY, of Manchester, show, among other fine examples of work, their latest production in the shape of a gear planing machine which is quite a departure from anything yet attempted, but as the makers are not quite prepared to publish a detailed description we can only give an illustration and a few of the salient points of the machine.

In the first place it is *entirely automatic*, which disposes of any serious attention during its operations.

It carries *two tools* in place of *one* usually used in gear planing, and is therefore capable of dealing with both sides of the tooth simultaneously.

The machine has a very wide range; cutting wheels from mitres to those having a ratio of four to one.

The form of tooth is produced by the machine itself, and is identical with the curves of wheel-teeth set out by the Odontograph, a method which is generally admitted to give the strongest form of gear tooth with the least amount of obliquity, and without having recourse to masters or formers of any kind.

The spacing of the teeth is made by division plates, and unlike the majority of wheel-cutting machines, using rotary cutters, which finish the space before dividing for the next cut, the blank is revolved the distance of the pitch at each stroke of the cutting tools, and the feed put on at each complete revolution of the blank, but is stopped automatically at the completion of the work.

The object of making a complete circuit of the blank before altering the cut is to prevent any variation consequent upon a tendency to heat at the point of operation. As many of our readers are aware, it has been found impossible to cut theoretically correct bevel wheels by means of a rotary cutter, as the variation of the tooth curve necessitates an altered form for the whole of the distance from the larger to the smaller end of the tooth.

Many bevel wheels are cut, however, by manipulating the cutter so that one side of the tooth is produced at a time. This operation at its best is unsatisfactory, as it is only an approximation to accuracy, accompanied with a great deal of setting of headstock and slides to the necessary angles.

With Messrs. Smith & Coventry's machine it is possible to cut what are apparently ideal and theoretically correct teeth, judging from the specimens of mitre gears cut on the machine.

(To be continued.)

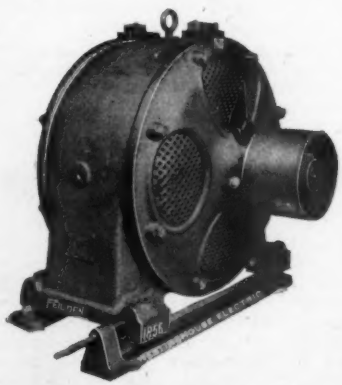
SOME RECENT APPLICATIONS OF THE ALTERNATE-CURRENT MOTOR.

IN the general all-round developments of electrical apparatus of the past few years, not the least important have been the advances made in the construction and application of alternate-current motors. Multiphase motors are now reliable and economical in their working, and have been adopted for both large and small work to a considerable extent. The single-phase alternate-current motor is, however, not yet a convenient form of apparatus for driving power, and it is in the development of the single-phase motor that so much is required, and which will improve the general conditions of power distribution by electricity to a still greater extent.

As it is, the improvements in two-phase and three-phase motor design have helped considerably to advance the field of electrical power transmission and distribution, and, at the same time, tends to show that a time is approaching when we shall have an equally reliable and efficient single-phase motor.

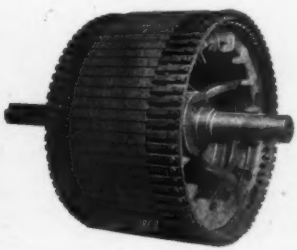
Until quite recently it was necessary to use a direct-current system of distribution if electricity for power purposes was desired. With this the area of distribution was exceedingly limited because of the unreliability of high-pressure direct-current apparatus. Even if the current be generated at low pressure with direct current, it is necessary to have rotating machines for the purpose of raising the pressure for transmission lines, and at the receiving end of the line a similar machine for reducing the pressure for the motor circuits.

These direct-current converters, being rotating machines and carrying high-pressure currents on their commutators and rotating parts, are very liable to breakdowns, require constant attendance, and a comparatively large amount of floor space. In alternate-current systems pressure is changed by

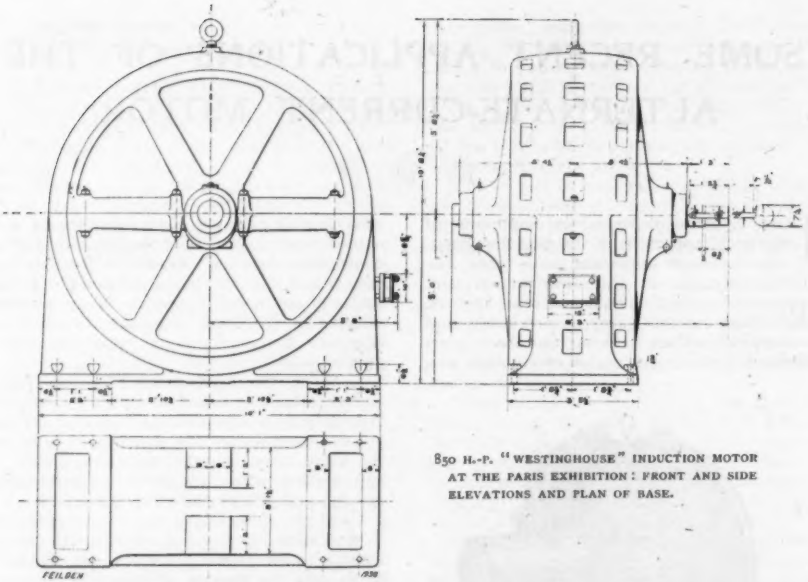


"WESTINGHOUSE" INDUCTION MOTOR.

THE "STATOR."



THE "ROTOR."



850 H.-P. "WESTINGHOUSE" INDUCTION MOTOR AT THE PARIS EXHIBITION: FRONT AND SIDE ELEVATIONS AND PLAN OF BASE.

means of transformers in which are no moving parts and no interrupted contacts, thus these static transformers lend themselves to the highest forms of insulation, require no attendance, and may be placed in any position not requiring valuable floor space. It was this easy transformation by means of static transformers which in past years chiefly caused the alternate current to hold its own against direct current when only lighting circuits had to be supplied.

Alternate-current motors are now operating in sizes varying from the tiny drawing-room fan motor up to the great motors which are used for power generation for railway and other large power-consuming schemes, as, for example, the two Westinghouse motors of 850 h.p. each which drive the generating plant providing power for the moving platform and the electric railway of the Paris Exhibition. These are the largest alternate-current motors ever made, and, judging by the way in which they have so far acquitted themselves, the maximum limit of size is not by any means reached even by them.

Drawings are given of the motors, and our supplement plate gives a general view of their external appearance. They are 10 ft. 8¼ ins. in extreme height; have a width, not including the shaft, of 6 ft. 9 ins.; and are 10 ft. 1 in. in depth. The shaft has a diameter of 7 3/16 ins., and a total length of 8 ft. 3 ins. There are several other dimensions shown on the drawings. They are run direct on a three-phase 5,000-volt circuit; the frequency of the supply is 25 per second, and the normal speed of each motor is 290 revolutions per minute. The motors are direct coupled, each to a 650-kilo-watt direct-current generator, from which the moving platform and the electrical railway are supplied with current at a pressure of 550 volts.

The electrical efficiency of the combined sets is 93 per cent. each at full load.

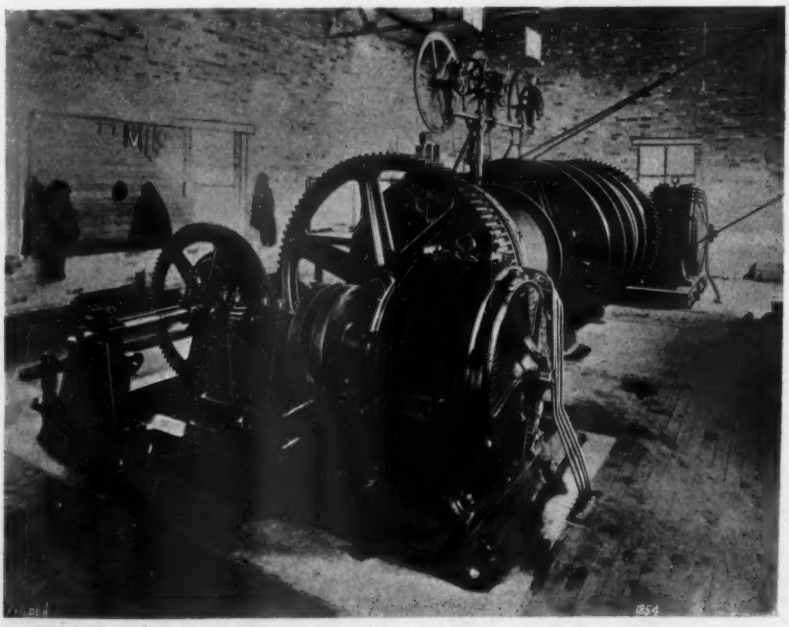
Some illustrations are given of this type of motor, which has during the last few years come into very extensive use. The motor works on the principle discovered by Tesla, the American inventor, whose name is so well known in connection with very high pressure and very long distance transmission work. It is really a transformer in which the secondary is a closed circuit, balanced and arranged on a spindle or shaft, so that it can rotate freely. The primary or "stator" is wound on a fixed ring outside the secondary or "rotor." The mechanical simplicity of this arrangement is evident. The rotor is built up of slotted soft steel laminated discs bolted on to an open spider

fitted and keyed to the motor shaft. Copper conductors are carried in the disc slots, and each is bolted at the ends to a solid copper ring. Thus the whole of the secondary circuit and the rotating parts are strong and rigid. Being all short-circuited windings, no attention need be paid to the special insulation of the bars in their length.

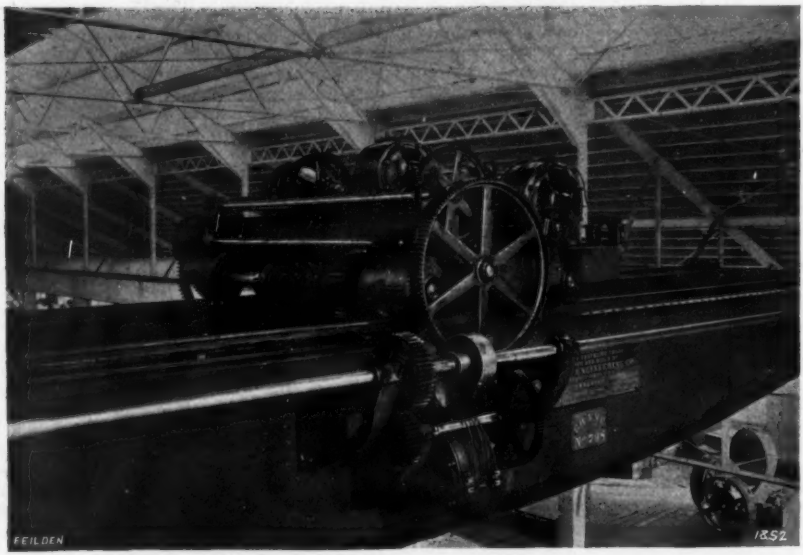
The stator is built up of laminated rings, slotted in the inside to receive the primary coils. The rings are bolted together, and fixed rigidly inside the cast-iron framework of the motor. In the large-sized motors the rings are not continuous; they are made up of segments, dovetailed, and fitted into corresponding slots in a hollow cylindrical shell of cast iron. In the smaller sizes the conductors consist of well insulated machine-wound coils, which are wound and insulated before being placed in the slots of the ring. In the larger sizes, copper bars bent to shape and well insulated are used as primary conductors. The leads to these coils are brought out to terminal blocks on the top or sides of the motor case. The frame of the motor supports the two end brackets carrying the self-oiling bearings. These brackets are fitted with perforated iron plates, which protect and enclose the whole of the rotor. If it is required to have the motors perfectly dust proof, solid plates are substituted in place of the perforated ones.

These motors are made to run either for constant speed or variable speed purposes. The only difference required in their construction is that for variable speed the closed circuit of the motor is made of higher resistance than it would be for constant speed running. For variable speed running a transformer with a sub-divided secondary circuit is used, the motor being coupled across different parts of this as changes in speed are required.

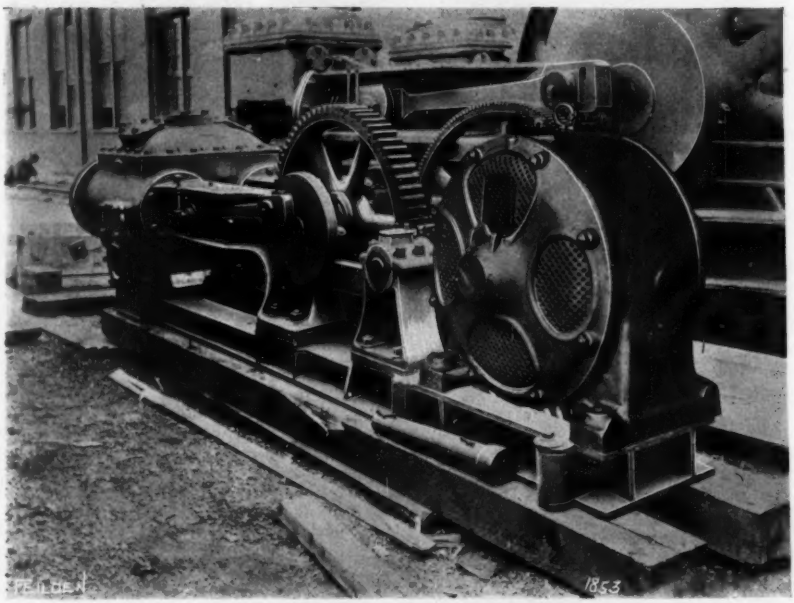
The smaller sizes of motors, whether two- or three-phase, are started by coupling them direct on the mains. In the case of the larger sizes the motor is started up, as a rule, with a current at lower pressure than its normal running current; for this purpose an "auto-starter" is provided which consists of a small transformer and a two-way switch. The first position of the switch puts the



"WESTINGHOUSE" INDUCTION MOTOR OPERATING MINE HOISTS.



"WESTINGHOUSE" INDUCTION MOTOR OPERATING A TRAVELLING CRANE.



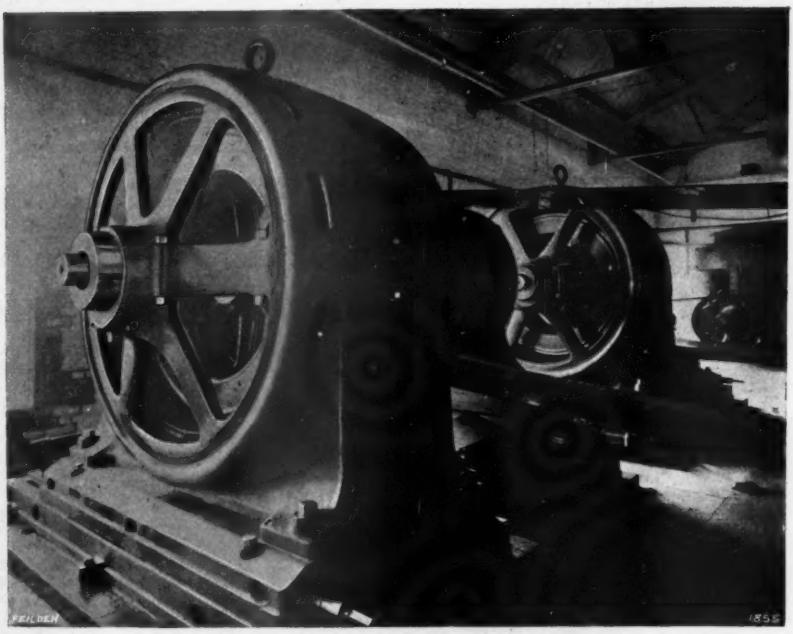
"WESTINGHOUSE" INDUCTION MOTOR OPERATING A PUMP.

mains across the primary of the transformer, and the motor across the secondary side. The motor then runs up to a certain speed, and the switch is thrown over, the effect of this being to disconnect the transformer from the main circuit and the motor from the transformer, and to place the motor direct across the main circuit.

From the secondary circuits of the transformer several loops are brought out, so that the lowest pressure required to start a motor may be obtained. The loops required for low-pressure loops, and a slight starting torque is obtained, with a corresponding reduction of expense.

The "auto-starter" can, of course, be installed and operated at any distance from the motor, so that the motor may be running with perfect safety in inflammable or explosive surroundings, and the switch, with its occasional sparkings, can be placed where no danger is likely to be caused thereby. (See Fig. on page 462.)

These Westinghouse motors are equal to



"WESTINGHOUSE" INDUCTION MOTOR DRIVING LIGHTING GENERATOR AT NIAGARA.

the starting of a certain motor under a certain load are brought out, and coupled to the terminals of the first position of the starting switch.

The result of this arrangement is that the starting torque is adjusted to the requirements of each motor, thus a motor coupled to a machine having great inertia is connected to loops having high pressures between them, and consequently a strong starting torque is produced. With a motor driving a light machine, the starting switch is connected to

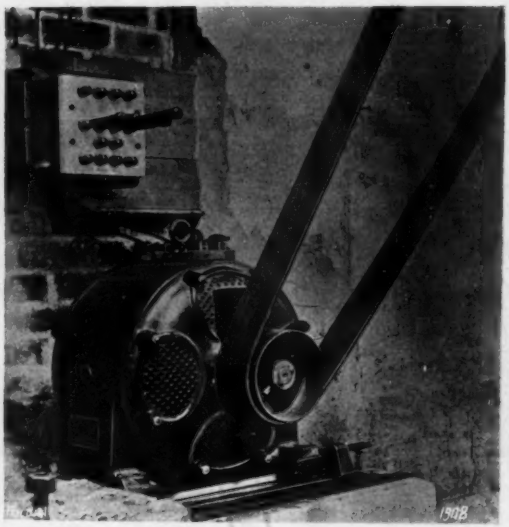
direct-current motors so far as starting torque and electrical efficiency are concerned, but they are superior to them in many other ways; they have no sliding or interrupted electrical contacts, with their usual wear and tear and dangers of fire or explosions from sparks; they will stand very much greater overloads; there are no coils on the rotor or rotating parts which can burn out, and their speed variation between no- and full-load is considerably less than is the case with direct-current machines.

Some illustrations are given showing to a slight extent the various classes of work to which these motors have been applied. Figures 1, 2, and 3 show the main parts of the motor construction, which is practically the same for all sizes. The other illustrations are taken from plants which are in actual operation.

They are not used solely in connection with long distance transmission schemes; they are used in preference to direct-current motors in many mills and factories where the generating plant is on the premises.

In such places as coal mines, powder mills, textile factories, and all places where highly inflammable goods are manufactured or stored, these motors have no rival, and it is in these places that so many have been installed.

In short, appearances tend to denote the fact that electric lighting and power will be accomplished entirely by alternating currents in the near future, and alternating generators will become so much the standard of electrical power that even for special work, such as electro-chemistry, electrical storage, or arc lighting, rotary converters or rectifiers will be used to change part of the alternate current to direct.



"WESTINGHOUSE" INDUCTION MOTOR OPERATING BLEACH WORKS, SHOWING AUTO-STARTER.

WORKSHOP PRACTICE

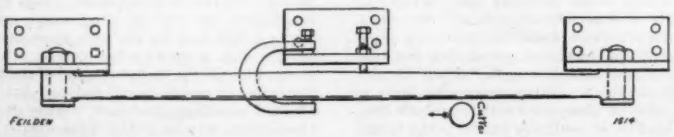
The purport of this section of FEILDEN'S MAGAZINE is to give the skilled mechanic in our great industrial establishments an opportunity of bringing his practical ideas and experience into print. Inventive capacity and careful thought on the part of the workman is what we desire to encourage and foster. To this end we invite skilled mechanics, foremen, under-foremen, and heads of departments, to communicate practical suggestions, which, if accepted, will be suitably paid for. Wherever possible, drawings should accompany the contribution; rough sketches will suffice, as, when draughtsmanship is at fault, we will do all that is necessary to render them fit for publication. Nothing will be too poor for a careful inspection. It will be seen that those contributions which appear in this section show distinct merit, and are both interesting and instructive.

❀ ❀ ❀

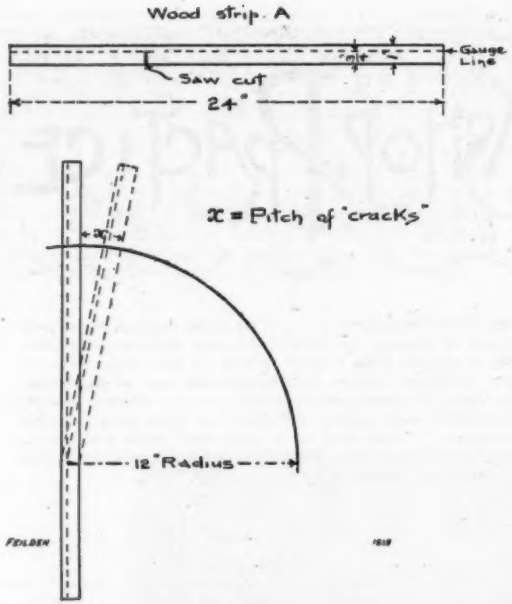
Machining Long Rods.—The sketch shows a very economical method of machining rods of rectangular section having a taper, such as locomotive coupling rods. After the rods have left the forge they have their vertical edges at the end planed on both sides. The holes for the bushes are then drilled and rymered out. These rods have a slight taper, being about $\frac{1}{8}$ in. thicker in the middle than at the ends. To get this taper they are sent to the vertical milling machine (or horizontal, if more convenient). Two rods at a time can be bolted up to angle plates (one above the other), secured at either end, and set so that the centre of the rod is parallel with the traverse of the table. Another angle plate is bolted to the table between the first two, as shown, having four set screws and check nuts in it, two of which press against each rod. A clamp is then put round each rod and the angle plate, and screwed up until the centre dabs making the thickest and thinnest parts of the rod are in one straight line. If the rod is $\frac{1}{8}$ in. thicker at one part, that part is pulled away from the cutter $\frac{1}{16}$ in. The rod is finished in the thickest part, and the tool leaves no mark. After the rod has been sprung, the set screws are screwed up to the rod, and so prevent vibration.

H. M. HALLSWORTH.

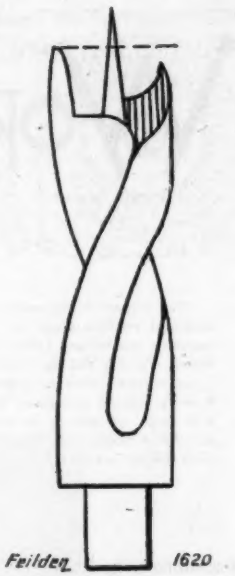
Saw Draughting.—The sketch shews a simple method of finding the pitch and depth of saw cuts necessary to bend a strip of wood to any desired radius—technically known as "cracking." Say it is desired to form a curb or segment 24 ins. long by 1 in. square to a radius of 12 ins. Prepare the strip *A* to the length and thickness, and gauge mark a line along its whole length, say $\frac{3}{4}$ in. from one side. This will represent the depths of the "cracks." Now saw one crack to the marked depth. Next, with a compass or trammel describe an arc of a circle of 12 ins. radius. Draw a line through the centre cutting the circumference; and upon this line place the strip of wood with the "crack" upon the centre. Holding the lower



MACHINING LONG RODS.



SAW DRAUGHTING.



DRILLING LONG HOLES IN WOOD.

part firmly in position, move the upper end forward along the arc until the edges of the "crack" are close. The distance thus moved on the arc should be noted, and is the correct pitch of "cracks" which will enable the strip to bend to the desired radius.

ERNEST SAMUEL.

Drilling Long Holes in Wood.—It frequently happens in machine shops that bolt holes have to be bored in wooden frames, beams, etc., and this occasionally presents a slight difficulty, as ordinary drills are useless, and a common bit centre is also frequently so, due to the fact that it will only go through about 4 ins.; again, hand augurs are slow and not at all reliable. For years I have used bits made as per sketch, and find them better in every respect than any bit that can be bought. Take the stump of an old twist drill—if there is only an inch of twist left on it, it will do—file a shank on the plain end, and braze it on to a piece of round iron $\frac{1}{16}$ in. less in diameter than the drill itself, and of any suitable length. Then file the end of drill to sketch. When tempering leave it so that it can be sharpened with a smooth file. It can be held in an ordinary chuck in the lathe, and can be run at any speed—the quicker the better. It will bore a beautifully clean hole in hard or soft wood in either direction of the grain, and when started rightly rarely runs out of line. It can always be relied upon to bore exactly the same sized hole, and can be used down to the last bit of twist. I have one now that has been in use about ten years, and during that time it has bored many thousands of holes, and is now as good as on the day it was made.

H. BENTLEY.

Attachments for a Loose Headstock. — In small lathe work the centre of the loose headstock may frequently be replaced by other contrivances, such as are illustrated opposite, and some of which are so generally useful as to be found upon the lists of several lathe-makers. Fig. 1, which is sketched from a manufacturer's catalogue, shows a revolvable vee centre, used in drilling holes through the axis of round work. Fig. 2 shows an attachment for use in filing small arbors, and Fig. 3 a drill feed for use with sheet metal or flat work. Fig. 4 shows a half centre, which allows more room for the tool at the end of the work than the ordinary centre does, and for that reason is adopted in milling machines. With these simple attachments may be included the square centre for centring work afterwards to be placed between the centres. These special centres, it will be noted,

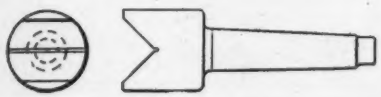


FIG. 1.

FIG. 2.

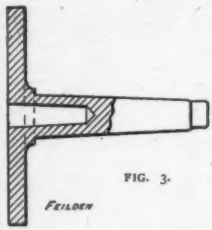


FIG. 3.

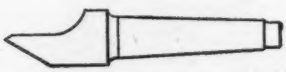


FIG. 4.

ATTACHMENTS FOR A LOOSE HEADSTOCK.

all fit the tapered hole in the sleeve of the loose headstock, and therefore can be made true and without shake. Attachments which fasten upon the outside of the sleeve necessitate the fit being parallel, and therefore cannot be tight of itself. If a set screw at the side is used for clamping purposes, it tends to throw the attachment out of truth, and to damage the sleeve—a serious matter when the importance of the accurate fit of this sleeve in the loose headstock is considered. The loose headstock may further be used to carry a turret attachment, which should be fitted in the above manner. The holes for the tool boxes are locked when co-axial with the sleeve, and hence no change of angular position of the turret as a whole will disturb the setting of the tool. At least two such turret attachments are upon the market, and, I believe, are in considerable demand.

JAMES J. GUEST.

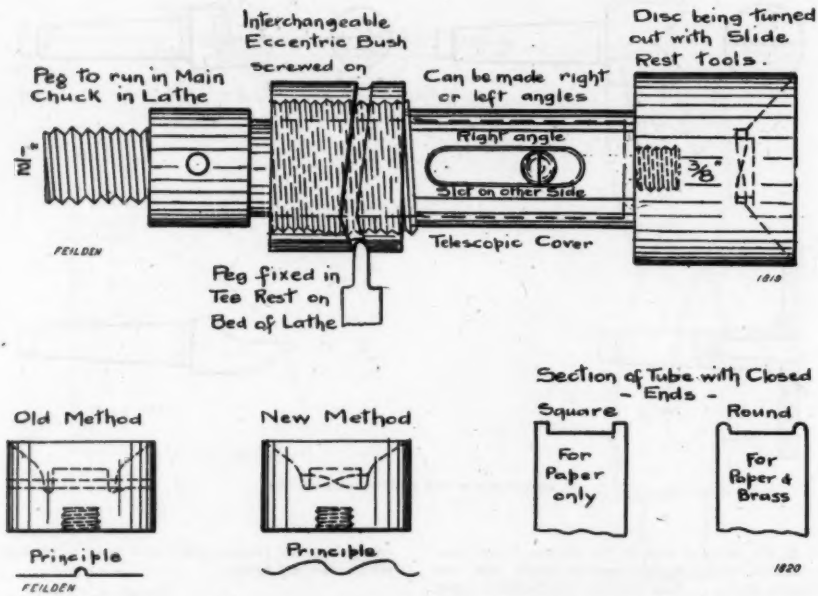
Cast-Iron Wheels.—As a large number of users of toothed gearing still prefer a machine-moulded cast-iron wheel, my experience in the use of these may be of service. I have now a firm belief in shrouded or webbed wheels, and if made in the following manner, results far exceeding ordinary practice will be obtained. Cast the shrouds sufficiently large in diameter to allow them to be turned exactly to pitch line; the extra cost of this will be more than balanced by the increased life of the wheel. When erecting the wheels, let the shrouds touch, and when set in motion, the tendency to spread the centres will clear the shrouds. This method ensures the wheels being kept in proper gear, and is of advantage when resetting again.

JAMES R. KELLY.

Clean Oil.—It is a somewhat difficult matter to keep oil really clean on a workman's bench in the cast iron cup or small tin usually provided. All the floating dirt in the atmosphere and the filings thrown off from the vice seem to gravitate towards the oil cup, and clean oil is soon at a premium. I have found it a good idea to adopt the ink-well usually inserted in school desks. I refer to those with a sliding cover. By making a hole in the work bench to take the well, and fastening round the sliding cover in exactly the same fashion as in the school desk, it is possible to keep your oil clean, impossible to knock it over, and it is never in the way.

S. MILLS.

Telescopic Eccentric Ratchet Turning Chuck.—On the next page is a sketch of a chuck which I have found very useful in turning out recesses in discs used for turning over the ends of paper and light brass tubes. The old system of turning over the ends of cartridges by discs made with two pins across a recess has never been satisfactory, as it turns over the edges of the tubes to such an extent as to condemn both disc and tube, although indispensable to the article being closed. To overcome this difficulty I have designed the above tool to make the turning-over discs, and same can be



TELESCOPIC ECCENTRIC RATCHET TURNING CHUCK.

adapted to any lathe. The idea of this tool is to turn out the recesses of the discs on the ratchet principle, two steps in the circle being sufficient to roll over the ends of the tubes in an easy manner, and also burnishing the roll over, which is so different to the old method. The secret of closing the ends of these tubes is that they would gently ride up the ratchet slope, and not across pins, as in the old way. These discs can be turned out round or square, to suit the fancy. Paper tubes are turned over with the greatest ease, square or round, but brass tubes will only turn over round unless a square ring be enclosed. These discs can be adapted for sporting cartridges, sealing up tubes, etc., and the manufacturing of all kinds of tubular bases.

THOS. BONEHILL.

The Attention of Employers of Labour

in our great industrial-engineering establishments is specially directed to the announcement under the heading "WORKSHOP PRACTICE." Inventive capacity among workmen is much more encouraged by the masters in the United States than in Great Britain, and the result is apparent in the many new practical ideas which come quickly to the fore in that country. Those British manufacturers among our numerous subscribers and readers who will assist us in popularising this section will be rendering themselves a real service.

INDUSTRIAL PROGRESS

ENGINEERING NOTES AND COMMERCIAL INFORMATION

FROM ALL SOURCES.

CIVIL ENGINEERING.

The Elbe-Trave Canal.—The canal connecting the Elbe and Trave rivers in Germany, which has been frequently discussed in the engineering press of this and other countries, owing to the remarkable syphon locks, designed by Mr. Hottop, with which it is furnished, and which was opened to traffic in the middle of June this year, represents the following features:—It has a length of 67 kilometres (42 miles), and connects Lauenburg on the Elbe with Lübeck on the Trave, on whose regularisation the Free Town of Lübeck is spending very considerable sums. The canal follows the old Stecknitz Canal route. That canal, which utilised the courses of two tributaries, flowing the one into the Elbe, the other into the Trave, was built in 1393 to 1398, and remained a useful water-way in spite of many, chiefly political, difficulties till the end of the sixteenth century. The diversion of the salt trade, which passed into British hands, hastened the decay of the canal. The new canal is fed from Lake Moelln, situated about the middle of the line, and descends to the Elbe in two, and to the Trave in five, locks. The chief engineers were Rehder and Hottop, and the chief contractors C. Vering, of Hamburg, and Ph. Holtzmann, of Frankfurt-on-the-Main. The construction has not involved any particular difficulties, but the Wakenitz River, which drives some mills, and discharges its water into some lakes close to Lübeck, under a head of several feet, into the Trave, caused some trouble. This river is now cut by the canal, and the water taken through two syphons, about 5 ft. in diameter, 20 ft. underneath the canal level; the pit descends to 32 ft. below that level. Very interesting are, further (apart from the peculiar locks, which apparently work quite satisfactorily), the 31 bridges crossing the canal. though none of them are of any noteworthy dimensions. The canal, it must be mentioned, has a width of 22 metres (72 ft.), and a depth of 6·7 ft., and is further to be widened on the one side and deepened to 8 ft. 3 ins. At Lauenburg, the roadway crosses by a bridge which is raised by the canal itself, being held by floats moving in cylindrical shafts; the bridge can be lowered with the aid of counter-weights. For the high road at Moelln, a cantilever arched bridge has been adopted. Among the several bridges at Lübeck is a handsome suspension bridge, whose two double pillars oscillate about their footsteps. The Burgthor Bridge, 290 ft. long, has its middle part, to a length of 80 ft., suspended between the lateral members, and three bridges cross the canal near the Hafenstrasse. Of these, one is a fixed high-level foot-bridge, and the two others, for the railway and carriage traffic, are worked hydraulically, the hydraulic pipe resting on the stationary foot-bridge.

Paving Blocks from Waste Material.—The owners of quarries in all countries will hail with satisfaction an invention which promises to relieve them of a great deal of trouble and expense, due to the difficulty of getting rid of the vast amount of refuse that attends all kinds of quarrying. Mr. Evan Reese, of the Eva Welsh Slate Quarries, in Wales, has been engaged for many years in experiments at Machynlleth for the purpose of ascertaining whether such waste material cannot be rendered useful for paving, and it is now stated that he has succeeded, by certain binding materials, in manufacturing bricks or blocks that possess a hard yet gripping surface, excellently adapted for the object desired. According to the *Quarry and Builders' Merchant*, the cost of such blocks for paving is much less than that of the granite sett, while it possesses advantage over the native block or sett in that it is not slippery and is not noisy when in use. It can be moulded into any form without increasing the cost. In combination with this stone-chipping or dust, other materials are added to suit the degree of hardness of the surface, silent or otherwise, that may be required. The apparatus and plant required being simple and inexpensive, the operation of brick or block making can be carried on adjacent to the heaps of *débris*, and the cost of carriage of the raw material is thus avoided. If this artificial stone is really of the quality claimed for it, and can be readily moulded into required forms, it might find a field of usefulness in furnishing large blocks, with bolt holes formed, for machinery and engine foundations.

MECHANICAL ENGINEERING.

Superheated Steam in the Steam Turbine.—One of the most fertile sources of loss in the ordinary reciprocating engine and the common rotary engines is cylinder condensation, and to the absence of this phenomenon must be ascribed in a

high degree the remarkable results obtained with the best types of steam turbines. At a first glance it might appear that the use of superheated steam in such turbines could hardly increase their output in any other way than through an increase of thermodynamic efficiency, as when a steam turbine is steadily at work the interior surfaces are practically at constant temperature. Recent experiments, however, made at Sibley College, in the United States, have demonstrated that there is an actual gain of 1 per cent. for every 3 degrees Fahrenheit of superheat, which is accompanied by an increase in the capacity of the turbine of about 100 per cent. for 37 degrees Fahrenheit of superheat. The cause of these gains from superheating is surmised to be the removal of the friction which is present when saturated steam is passing through the turbine, in which case there is a retardation of the flow of the steam, due to moisture in the form of drops and mist which clings to the walls of the steam passages in the turbine. This view of the case is corroborated by the fact that the gain, as far as the experiments go, is nearly proportional to the degree of superheating. Professor Thurston, under whose careful supervision the experiments in the celebrated engineering school were made, has undoubtedly added, in the above, a very valuable contribution to our practical knowledge.

Refuse Destructors.—Among the various types of refuse destructors those of Messrs. Heenan & Froude, of Farnworth, near Bolton, seem to be among the most efficient in the market, and in consequence of the recommendation of Mr. Hammond, the Electrical Engineer, and Mr. Read, the City Surveyor of the Gloucester City Council, who had carefully examined a number of refuse destructors of various firms, the corporation decided to adopt the destructor of Messrs. Heenan & Froude in preference to all others. One of the twin-cell destructors of this firm has been in operation at Gloucester, at the expense of the makers, for some nine months. It consists, as its name indicates, of two cells side by side, only separated from each other by a low bridge, like that at the back of a boiler, so that an open communication exists between the two cells. Each cell has a charging door on one side of the furnace corresponding to the clinkering door on the opposite side, and the combustion chamber is placed above the two cells, extending the whole length of them; and above the combustion chamber is fixed the boiler. The feeding is done through a hopper, which is provided in connection with each charging door, so that the refuse can be put straight on to the grate bars, and the men on the clinkering side can also pull it forward, if necessary; so that there is a direct course, either by pushing from the charging door or pulling from the clinkering door, to get the refuse into the grate. The blast is fed to the underside of the ash-pit, the grate being supplied with air blast by a fan, the steam blast by a jet, the whole under entire control. The main feature of the destructor is that by simply altering the direction of the damper the gases from either grate can be alternately made to travel over the other grate, and so on into the combustion chamber, and finally into the tubes of the boiler. Charging and clinkering take place alternately, first with one cell, and then with the other, so that there is always a hot fire in the one cell to cremate the smoke and fumes from the other. The two experts named recommended this destructor on account of the fact that it is decidedly economical in space and in heat efficiency, and gives a splendid clinker. The contractors, moreover, submitted an amended plan, by which the furnace is much strengthened and improved in value, and the boiler supported in such a way that the brickwork can always be repaired without necessitating the removal of the boiler. They guarantee consumption of 12½ tons per cell per twenty-four hours, and also guarantee to evaporate 1¼ to 2 lbs. of water from, and at, 212° Fahr. per pound of refuse, while their tender was £4,150. Though this was not the lowest bid, the committee strongly recommended its adoption, being of the opinion that Gloucester should have the best and most suitable destructor obtainable, and a matter of £100 should not stand in the way.

Coal Dust as Suitable Fuel for all Boilers.—At the present period of extravagant prices for coal the value of the lower grades deserves special attention, and the experiments made with coal-dust as fuel are of special interest. One such experiment made in Holland appears to have given very satisfactory results. At the Wester Refinery, Amsterdam, where 80,000 tons of sugar are annually produced, a single Cornish boiler has been working continuously night and day for two years, and five others for the last 12 months, with coal dust fuel supplied by "Freitag's Automatic Feeder." The coal is ground as required in a mill attached to the fire-box, and delivered directly into it; consequently there is no dust in the boiler-house. There are 22 boilers in use at the Refinery. These were fitted in 1887 with Leach's automatic stokers, which provides an even and regular supply of coal. Freitag has retained these stokers to feed his mills, of which there are two fixed to each boiler. The sides of the mill are transparent, and the front works on a hinge to admit of the removal of the revolving screen, pulveriser, and other parts liable to wear. The pulveriser consists of a solid steel collar fixed on a revolving shaft, to which are bolted and keyed four projecting arms faced with chilled-steel removable bits. The shaft is driven by belting or an electro-motor. Immediately below the delivery pipes is a series of orifices which admit air along with the coal dust, and below these again a door through which the ash and slag are removed twice daily. The boilers are Cornish, 7 ft. 10½ in. in diameter, 31 ft. long, with 2 ft. 8½ in. flues, and 1,033 super. ft. of heating surface, working at a pressure of 8 atm.; temperature of feed-water, 40 degs. Cent. The gases leaving the flues register from 270 to 350 degs. Cent., and contain from 16 to 20 per cent. of carbonic oxide; 1,164 to 1,712 lbs. of steam are generated per foot of heating surface per hour, and the mill makes 1,500 revolutions per minute

with an expenditure of 2·4 h.p. These results are compiled from the register of daily work, and not from experiments. All parts of the machine are easy of access, and so light that one man can handle them. The system is applicable to all classes of boilers, both marine and locomotive.

ELECTRICAL ENGINEERING.

New Anglo-German Cable.—The German Reichstag has under consideration the construction of a new telegraph line between Germany and England, and an addition of 2,000,000 marks to the budget has been demanded for this object. The necessity of the new line is due to the fact that since the laying of the fourth cable in 1896 the number of telegrams has continued to increase in a very rapid manner, and has risen from 1,867,868 in 1895 to 2,465,613 in 1899, which represents an overcrowding prejudicial to the business interests of both countries. The new telegraph line will start from Borkum in Germany to the coast of Norfolk, and will be constructed in agreement with the British telegraph administration. The equipment is to comprise all the most recent improvements in telegraph engineering, and the expense will be supported in common, excepting the junction lines proceeding from the terminal stations, which will be borne by the Government of the country in which they are situated.

Progress of Electrical Engineering in the United States.—Americans can hardly be blamed for being proud of their progress in electrical engineering, since the latest statistics show that it has been remarkable in the fullest degree. During the first eleven months of the fiscal year 1900 the exports of electrical machinery reached in value a total of $3,834,317, as compared with $2,517,707 for the same period of the previous year, and $1,883,306 for 1898. The exports of instruments and apparatus for scientific purposes, under which heading are included telegraph, telephone, and other electric apparatus, during the first eleven months of 1898 were valued at $2,521,280, increasing to $3,929,073 in 1899, and to $5,876,618 during the corresponding eleven months in the fiscal year ending in 1900. Our trans-atlantic competitors, however, seem not yet even to be satisfied, and constantly exhort each other to keep a watchful eye on European progress. They are right in doing so, for to maintain the first position in any industry is far more difficult than to obtain it, as British manufacturers have no doubt realised by this time.

The Electric Kitchen at the Paris Exhibition.—It was found desirable to establish a restaurant in the Spanish Pavilion in the grounds of the Paris Exhibition, but on applying for a licence the concessionaire was informed that his application could be granted only on the condition that there should be no burning of coal, gas, or oil, in order to avoid smoke and also in order to avoid the danger of a fire. Under these circumstances there remained but the use of electricity for cooking purposes, and this way out of the dilemma was ultimately adopted. With the assistance of a French firm a highly elaborate electric kitchen was established, and, since the opening on April 24th, more than 22,000 persons have partaken of dinners cooked by means of electricity. The maximum current used in the establishment is 850 amp. at 110 volts. About 70 kilowatt-hrs. per day are consumed in keeping hot coffee, chocolate, and other hot drinks, while about 280 kilowatt-hrs. are used in regular cooking, representing an output of about 450 watt-hrs. for each service of food to a guest. As the price paid for electrical energy is 4¾*d.* per kilowatt-hr., the cost of the mean consumption per guest amounts to about 3*d.* The electrically-heated apparatus is of the "Parvillée" type, in which a metallic powder is mixed with various proportions of a non-conducting enamel so as to form blocks of high-resistance material, well adapted to transform the electric energy of the current into heat. The inventors of this process claim that this type of high-resistance material can be carried to incandescence in the open air without being damaged. Plates of this compound 2 ins. by 4 ins., and $\frac{1}{8}$-in. thick have a total resistance of 100 ohms, or about a million times greater than that of the metal in the compound. This compound is estimated to absorb 16.5 watts per kilogram. The oven in the electric kitchen, having a size of 4 ft. by 7 ft., is provided with eight heaters, which can be carried to a temperature of 1,200 degs. centigrade. Four of the heater plates consume 25 amps. each, the other four only 20 amps. each. Besides there is a roasting oven, in which the meat is roasted over red-hot plates, for the heating of which 35 amps. are consumed, while another oven, somewhat smaller, consumes 25 amps. Besides these there are two ovens, one of which is heated from the base, and the other from the top, absorbing up to 20 and 50 amps. respectively, in the latter of which 75 lbs. of meat can be roasted in about three hours with a mean current of 40 amps. The water boiler in the kitchen having a capacity of 30 qts. consumes 20 amps., and a soup kettle of the same capacity consumes the same amount. In addition to this there are numerous smaller hot-plates for heating coffee-pots, tea-pots, etc., and a water-bath, or water steam-cooler, using 20 amps. of current. The whole represents one of the most complete electric cooking-plants ever constructed.

Utilising River Power.—According to an American contemporary, the Russian Minister of Finance has under consideration plans for the employment of the falls in the River Dnieper for producing electric power. The plans have been worked out by a corps of Russian army engineers, and with these a company has been formed by capitalists, who have set apart 6,000,000 roubles ($3,000,000) for the purpose of developing the plans as soon as the concession is granted by the Government. The company proposes to make the Dnieper navigable from Ekaterinoslav to

Alexandrovsk and transfer the power from the falls to the former city, where, of late, numerous factories, mills and mines have been opened. Some years ago an English company had been formed for the same purpose, but, owing to a severe press campaign against them, they were unable to obtain the concession. The Ekaterinoslav district is one chiefly of coal and ore mines, most of which are in the hands of the Belgians. It is stated that the Belgians have not less than from 700,000,000 to 800,000,000 roubles ($360,500,000 to $412,000,000) interested in this one district. So important are the interests of Belgium in the district of Ekaterinoslav that not long ago the Belgian Consulate-General at Odessa was transferred there. In Southern Russia this entire district goes under the name of New Belgium.

IRON AND STEEL.

Novel Method of Welding.—A very interesting paper was recently read by Dr. Goldschmidt, of Essen, at the meeting of the German Gas and Waterworks Association at Mayence, describing a new welding process invented by him, in which the heat is produced by a compound which he calls "thermit." This compound consists of a combination of metallic oxides with aluminium, and permits a fusible mass of an extremely high temperature to be produced quickly and in a simple manner. One of the uses of this compound is its employment in the production of chemically pure metals, free from carbon—such as chromium, manganese, vanadium, and ferro-boron—and it is also of importance in the production of ornamental ironwork. Its most interesting employment, however, is perhaps its use in welding pipes and rails, which by means of it can be welded immediately and economically and at any place, no other implement being required than a melting-pot. The process consists in pouring liquid thermit on to an iron sheet, which melts it instantaneously, and has been in successful operation in Essen, Brunswick and Hanover, for welding tram rails. The details of the process are as follows:—The melting-pot is filled with tar-oil, an inflammable mixture is added, and a match is used to ignite it. Spoonfuls of "thermit" are then added, which immediately ignites, and produces temperatures as high as 3,000 degs. Cent. The highly incandescent contents of the pot, which consist of iron, called alumino-thermo-iron, on the top of which floats melted carborundum; an aluminium oxide is then poured on the part of the rail to be welded, and the work is done so quickly that the melting-pot is cold and can be taken into the hand after being emptied.

RAILWAY AND ROAD TRACTION.

Awards for the 1,000-Mile Trial.—The report of the committee appointed to adjudicate on the result of this interesting trial draws attention to the fact that many of the competitors almost entirely disregarded the rules as to speed, and rushed through villages at an unreasonable and dangerous pace. Whether anything is to be gained by such riding on a long run is more than doubtful. "Haste makes waste," says the proverb, and break-downs or dangerous accidents are almost certain to more than counter-balance temporary advantages. Mr. C. S. Rolls, whose car obtained the first prize at the trial, deserved his success also by his moderation and his careful attention to the regulations, obtaining 93·22 out of a possible 100 marks awarded under this head. As regards the failures marked down to various vehicles, it is noteworthy that the majority of them was not due to defects in the motor or gearing, but to structural weakness of the conveyance, as is shown from break-downs of axles and from numerous instances of punctures of the pneumatic tyres. The competing motors were divided, for the purpose of the trial, into two classes—those entered by manufacturers and those entered by private owners. These classes were then subdivided into six groups, the larger vehicles forming four groups with reference to their cost, namely, those whose cost was less than £200, those that cost between £200 and £300, those that cost between £300 and £500, and finally, those whose price exceeded £500; while the smaller vehicles were divided into two groups, *i.e.* motor cycles and public service vehicles. The vehicle of the Hon. C. S. Rolls, a 12 h.p. Panhard car, which was awarded the gold medal, exceeded in cost £500. In the class of vehicles costing less than £200 a silver medal was awarded to a Benz "Ideal" motor, driven during the larger portion of the trial by Mrs. Bazalgette.

The First Sleeping Car Built in Japan.—At the Kobe shops of the Sanyo Railroad (3 ft. 6 ins. gauge) of Japan, three first-class sleeping and dining cars have been built this year under the supervision of Mr. Iwasaki, Locomotive Superintendent of the road, being the first cars of the kind built in that country. One of these has been running since April 8th, in night service, between Osaka and Mitajiri, 300 miles, 279 of which are served by the Sanyo Railroad and 21 miles by an Imperial Government line. An extra charge of 2 yen (4s.) is made for the use of a berth. On the dining section meals are served both *à la carte* and *table d'hôte*. The car is about 58 ft. long over buffers, 9 ft. wide over all, and 12 ft. high from rail to top of car. The sleeping compartment, which occupies nearly two-thirds of the length of the car, is fitted with two lavatories and eight lower and upper berths, each measuring 6 ft. 6 ins. in length and 3 ft. in width. The upper berths are ventilated. The dining section has a kitchen and four tables, accommodating eight persons at one time. The car has two six-wheel trucks, and is the first car in Japan fitted with more than eight wheels. It is equipped with vacuum brakes, is heated by steam, and lighted with electricity from a dynamo worked by a gas-engine placed in the luggage car of the train. According to Mr. K. Nishino, Traffic Manager of

the Sanyo Railroad, the car is very much in request, all the berths having been sold every night since the car was first placed in service.

An Efficient Miller's Dray.—Messrs. F. Coulthard & Co., Ltd., Preston, England, have placed upon the market a very efficient miller's dray, nominally to take a 2 or 3-ton load, but which, as some of their clients certify, carries much heavier loads. Thus Messrs. F. Skurray & Son, millers and corn merchants at Swindon, report that on one occasion recently the motor left the mill at 6 a.m. with 3 ton 4 cwt., to Faringdon, 12½ miles, arrived at 8.15, unloaded, and left again at 8.55; arrived at mill 11.10, loaded with 3 ton 3 cwt., and left at 12.10, arriving at Farringdon again at 2.35, unloaded and returned at 3.10, arriving at the mill at 5.30, thus doing 50 miles in 11½ hours, carrying her load for 25 miles, and returning in each case empty. The same firm states that on another occasion the motor took 33 tons to the station, and brought down 33 in ten journeys between 7 a.m. and 6 p.m., including half-an-hour for breakfast and one hour for dinner; while on a third occasion the motor was taken down a gradient 1 in 6, while empty, and a few days later it took a load of 3 ton 6 cwt. down a famous hill, the steepest part of which is 1 in 7, and has a length of about one mile. These facts speak for themselves, and it is not surprising that this dray, which is an oil-fired steam waggon, commands an excellent sale at home and abroad. In a paper read before the Millers' Convention on July 5th this year, Mr. E. C. Skurray compared the expense of horse haulage with that of the motor in question, and demonstrated that, while the cost of five horses, fittings, harness, two vans, stables, etc., amounted to about £730, the motor, including house and fittings, cost about £525, which is £205 less than the horse plant. The annual cost for maintaining the latter amounted to £428, while the maintenance of the motor plant, including interest and depreciation, fuel, repairs, lubricating oil, driver's wages, did not cost more than £295, showing a saving of, roughly, £122 per annum. Since the motor has done the work of the five horses, and even more, the balance is, of course, enormously in favour of the motor.

MISCELLANEOUS.

The Largest Engineering Society.—It is generally believed that the Institute of Civil Engineers in this country is the largest organisation of its kind in existence. The fact, however, is that the "Verein Deutscher Ingenieure" (Society of German Engineers), which now counts about 15,000 members, many of whom live abroad, occupies the first place, and publishes the most voluminous and most profusely illustrated transactions issued by any technical organisation. This society, according to the report of its Director for the year 1899, had during that year 41 branches, and the increase of its membership during the same period amounted to 1,081. The society's publication, known as the *Zeitschrift des Vereins Deutscher Ingenieure*, is a weekly journal, having a page of 12·5 × 9·5 in size, and containing among its illustrations numerous large folding plates. The text aggregates to about 1,600 pages per year, and the editorial staff consists of eight prominent engineers, aided by about twice the number of draughtsmen and assistants. The contributions comprise numerous special articles by correspondents, papers read at the various local branches, and leaders and editorials written by the editorial staff; while a special feature is a descriptive index to current technical literature, somewhat after the style of the "World's Engineering and Industrial Press" in FEILDEN'S MAGAZINE. The magnitude of the enterprise may be estimated from the fact that the expenditure on the part of the society for this publication amounted to about £25,000, against which is to be set £20,000 received from the publishers, one of the most noted firms of Germany, for advertisements, and £2,000 from the sale of the journal and separate papers. As the entrance fee is but 10s. and the annual subscription £1, the members obtain the journal at a very low cost.

Improved Belting.—An improved kind of belting is placed on the market by Messrs. Brown & Co., of 49, Deansgate, Manchester, under the name of "Young's Patent Grip Belting." It is made from a specially prepared leather, manufactured under a patented process from selected ox-hides, and, according to the claims of the manufacturers, excels in fitness of purpose, flexibility, holding power, and durability the best oak-tanned and "Helvetia" leather, being adapted to all kinds of conditions and working well, hot or cold, wet or dry. It is made of three or more layers firmly stitched and cemented together, and perforated with holes to allow the escape of the air between the belt and the pulley. The greatest strength is given to the centre of the belt, where, owing to the shape of the pulley, the greatest strain usually exists, which also aids in holding to the pulley and increases the power it will transmit. It seems well adapted for all main and heavy driving where heavy strains occur and great speed is required; for dynamos and motors, owing to its smoothness and regularity; for agricultural machinery, as it is not affected by moisture; and for all kinds of exposed machinery where the ordinary belting would be speedily injured.

Tin Barrels for Roller Blinds.—Among the minor features of mechanical progress may be mentioned the improved manufacture of tin barrels for spring and roller blinds, which are now produced by specially designed machinery and machine tools, as, for instance, in the works of Messrs. Hudson & Hudson, 19, Newman Passage, Newman Street, Oxford Street, London, W., where the manufacture is superintended, as we are informed, by a mechanic who received his training in the shops of Sir W. G. Armstrong, Whitworth & Co., Ltd., and in the works of D. Napier & Sons, Ltd. These barrels are made to

order in any style, and a sufficient quantity of all sizes is constantly kept in stock, being made of tin of the best quality only. Moreover, the firm undertakes also the work of joining together short ends that may accumulate toward the close of the season, in any length desired, thus rendering useful fragments which otherwise would have to be consigned to the scrap-heap.

Fuel Economy.—At present, when the price of coal has reached a height which is dangerously near the prohibitive limit, and when our manufacturers are not yet quite prepared for the substitution of a cheaper fuel—which, however, sooner or later they may have to decide upon, unless the colliery owners return to reason ere it is too late—all efficient devices for obtaining more power from the same amount of coal consumed are worthy of earnest attention. There are numerous systems of economising fuel in the market, many of which, however, though more or less reliable, are suitable only for special conditions; but a method which admits of the widest application and has, to judge from the testimonials of competent men, given excellent results is the covering of the boilers, steam-piping, stills, etc., by Messrs. Sutcliffe & Sutcliffe's "Telluric Cement." This Manchester firm has succeeded by its invention in reducing to a minimum the excessive condensation which occurs in long uncovered pipes, and, of course, is the cause of an enormous waste of fuel. Their cement covering is likely to increase in popularity when it becomes known in wider circles how much it saves on the coal bill. It is claimed in proof of its efficiency that—to cite one only of many cases—a well-known colliery company, which at one time had 600 yds. of 3 in. piping uncovered, and, in consequence, obtained with a mean steam-pressure at the boilers of over 60 lbs., only 24 to 25 lbs. at the engine in shaft, secured as soon as the covering had been adopted, an increase of pressure to 52 lbs. This reduction of labour at the boilers, and the saving in fuel in so simple a way, speak for themselves. Another speciality of Messrs. Sutcliffe & Sutcliffe is their so-called "Vicrolite"-packing, suitable for all kinds of steam engines, pumps, steam hammers, etc., and consisting of a combination of carefully selected and finely spun yarns with an admixture of an efficient heat-resisting lubricant, which stands the highest pressures, does not melt, char, or set hard, and allows of all being used up. Keeping the rods cool, bright and steam-tight, it retains its softness and lubricating qualities to the end. Those who have tried it state that its use saves both time and power, and any such saving is, now-a-days—for the reasons above given—of considerable importance.

New Torsion Dynamometer.—Since the publication of the last issue containing particulars and illustrations of this interesting and useful appliance, we have received numerous inquiries for the name and address of the makers. For the benefit of any who would know more concerning the apparatus, we would refer them to The Power Transmission and Traction Co., Hull Road Works, York.

Awards at the Paris Exposition.—We have pleasure in intimating that advices have reached us from the following firms as to the awards that have been made at the Paris Exhibition:

The United States Metallic Packing Co., Ltd., Bradford: Class 19, Metallic Packing for Stationary and Marine Engines—silver medal; Class 32, Metallic Packing for Locomotives—silver medal; Class 22, "Bradford" Portable Power Drill and Reamer—bronze medal. The silver medals which have been awarded to this firm's metallic packings represent the highest awards granted to any exhibitor of engine packings in the whole of the Exhibition. In addition, we may add, these packings are working on five large engines belonging to firms of five different European countries, each of which has been awarded the "Grand Prix."

Messrs. G. & J. Weir, Ltd., Cathcart, Glasgow. The marine specialities of this firm, a description of which appeared on page 204, have been awarded both a gold and silver medal.

The British Schuckert Electric Company, Ltd., Surrey Street, Strand, W.C., were represented in four sections, viz., Electrical Machinery and Motors, Electric Lighting Plant, General Plant, and Electrical Apparatus for Marine and Naval Purposes, and in all four cases have been awarded the "Grand Prix." The engineers and representatives of the firm have also received nine gold medals and eight silver and bronze medals.

The Campbell Gas Engine Co., Ltd., Halifax. A gold medal has been awarded this firm for their exhibit of Gas and Oil Engines, and, in addition, seven members of their staff, foremen and workmen, have been awarded silver and bronze medals for the work done by them in connection with the exhibit.

The Septic Tank System of Sewage Treatment Syndicate, Ltd., of Exeter, are the recipients of gold, silver and bronze medals.

Stern Bros., 57, Gracechurch Street, E.C., are the recipients of a "Grand Prix" and silver medal.

Robert Boby, Ltd., St. Andrew's Works, Bury St. Edmund's, have been awarded a gold medal for their exhibit of patent machinery for dressing and cleaning all kinds of grain, malt and seeds.

Errata.—Owing to a typographical error, on page 171 of our August issue, the up and down gradients of the Simplon Tunnel are given as 2 per 100 and 7 per 100 respectively. The figures should, of course, be 2 per 1,000 and 7 per 1,000, as is obvious from the other data contained on the same page.

We find that in error we inserted in Messrs. G. Salter & Co.'s announcement, on page lxvii. of our September issue, particulars of their No. 5 Typewriter, whereas the block illustrates their latest No. 6 machine; the price of which is £14 14s., and not £8 8s. as stated in the September announcement.

In this section is presented every month a concise précis of the contents of the leading organs of the technical press and of the proceedings of the learned societies throughout Great Britain, the Continent, and America, and also, in a summarised form, the subject matter of the more important articles appearing therein.

This systematic record should prove of the greatest value to those of our readers interested in one or more specific sections of technology, trade or economics, or to those who have insufficient leisure to peruse the large number of publications now appearing.

The following is an Index to the abbreviations used throughout the section. It gives an alphabetically-arranged list of the publications regularly reviewed, together with the place of publication. In most cases where publications are not readily procurable, with the exception of Transactions of the learned societies, copies of the articles can be supplied on application and by remitting 7d.

Am. Engr. ...	American Engineer	New York
Am. Machy. ...	American Machinery	New York
Am. Mach. ...	American Machinist	New York
Am. Mftr. and Ir. Wld.	American Manufacturer & Iron World	Pittsburg
Am. Shipbldr.	American Shipbuilder	New York
Ann. des Pts. et Chauss.	Annales des Ponts et Chaussées	Paris
Archt.	Architect	London
Arch. Rcd. ...	Architectural Record	New York
Arch. Rev. ...	Architectural Review	Boston U.S.A.
Arms and Exp.	Arms & Explosives...	London
Aust. Min. Stand.	Australian Mining Standard	Sydney
Autom. and Horstl. Veh. Journ.	Automotor and Horseless Vehicle Journal	London
Berg Hüttenm. Ztg.	Berg und Hüttenmannische Zeitung	Berlin
Board of Tr. Journ.	Board of Trade Journal	London
Brit. Archt. ..	British Architect ...	London
Bri. and Col. Prtr.	British & Colonial Printer	London
Bldr.	Builder...	London
Bldrs'. Journ.	Builders' Journal ...	London
Bull. d. l. Soc. d'Encour.	Bulletin de la Société d'encouragement	Paris
Canad. Elec. News	Canadian Electrical News	Toronto
Canad. Engr. ...	Canadian Engineer	Montreal
Can. Mftr. ...	Canadian Manufacturer	Toronto
Canad. Min. Rev.	Canadian Mining Review	Ottawa
Carr. Bldrs'. Journ.	Carriage Builders' Journal	London
Cass'. Mag. ...	Cassier's Magazine	London.
Chamb. of Com. Journ.	Chamber of Commerce Journal	London
Chem. Trds. Journ.	Chemical Trades Journal	Manchester
Coach Bldrs'. Art Journ.	Coach Builders' Art Journal	London
Cold Storage ...	Cold Storage ...	London
Coll. Guard. ..	Colliery Guardian ...	London
Comm. Int. ...	Commerce Intelligence	London
Compt. Rend. ...	Comptes Rendus de l'Acad. des Sciences	Paris
Compt. Rend. des Ing. Civ.	Compte Rendu de la Société des Ingénieurs Civils	Paris
Contr. Journ. ...	Contract Journal ...	London
Deutsch. Techn. Ztg.	Deutsche Techniker Zeitung	Berlin
Dingler's Polyt. Journ.	Dingler's Polytechnisches Journal	Stuttgart
Dipl. and Cons. Rpts.	Diplomatic & Consular Reports	London & Washington
Ech. d. Mines	Echo des Mines ...	Paris & Brussels
Ecl. Elect. ...	Eclairage Electrique	Paris
Elec. Engr. ...	Electrical Engineer	London
Elec. Engrg. ..	Electrical Engineering	Chicago
Elec. Rev., London	Electrical Review ...	London
Elec. Rev., New York	Electrical Review ...	New York
Elec. Wld. ...	Electrical World ...	New York
Electn.	Electrician	London
Electn., Paris ...	Electricien	Paris
Electrotechniker	Electrotechniker	Vienna
Electy., London	Electricity	London
Electy., New York	Electricity	New York
Elektrochem. Ztschrft.	Elektrochemische Zeitschrift	Berlin
Elektrotech. Ztschrft.	Elektrotechnische Zeitschrift	Berlin
Elettricita ...	Elettricita	Milan
Engr.	Engineer	London
Engr., Cleveland	Engineer	Cleveland, U.S.A.
Engrg.	Engineering ...	London
Engrg. and Min. Jour.	Engineering and Mining Journal	New York
Engrg. Mag. ...	Engineering Magazine	New York & London
Engrg. News ...	Engineering News ...	New York
Engrg. Rcd. ...	Engineering Record	New York
Engl. Mech. ...	English Mechanic ...	London & New York
Gas Wld. ...	Gas World	London
Gaz	Gaz, Le...	Paris
Gén. Civ. ...	Génie Civil	Paris
Ges. Ing. ...	Gesundheits-Ingenieur	Munich
Glaser's Ann. ..	Glaser's Ann. f. Gewerbe und Bauwesen	Berlin
Hrdw., Mets. and Machy.	Hardware, Metals & Machinery	London
Hrdw. Trds. Journ.	Hardware Trades Journal	London
Heatng. and Ventng.	Heating & Ventilating	New York
Hosiery Tr. Jr.	Hosiery Trade Journal	Leicester

Ice and Cld. Storge.	Ice & Cold Storage	London
Ill. Off. Journ. of Pat.	Illustrated Official Journal of Patents	London
Ind. and East Engr.	Indian & Eastern Engineer	Calcutta
Ind. Engrg.	Indian Engineering	Calcutta
Ind. Elec. Chim.	Industrie Electro Chimique	Paris
Ingrm.	Ingenorum	Copenhagen
	Irish Textile Journal	Belfast
Ir. Age.... ...	Iron Age	New York
Ir. and Coal Trds. Review	Iron and Coal Trades Review	London
Ir. and Steel Trds. Journ.	Iron & Steel Trades Journal	London
Irnmgr. ...	Ironmonger	London
Jr. Ass. Eng. Socs.	Journal of the Association of EngineeringSocieties	Philadelphia
Jrn. Chem. Soc.	Journal of the Chemical Society	London
Journ. of Comm.	Journal of Commerce	Melbourne
Journ. of Elec.	Journal of Electricity	San Francisco
Journ. of Electr. Power and Gas	Journal of Electricity Power and Gas	San Francisco
Journ. of Gas Lghtng.	Journal of Gas Lighting	London
	Journal Inst. Elec. Engrs.	
Journ. of Roy. Inst. of Br. Archts.	Journal of Royal Inst. of British Architects	London
Journ. of State Med.	Journal of State Medicine	London
Journ. of Soc. of Arts	Journal of the Society of Arts	London
Knowl.	Knowledge	London
Ldry. Journ. ...	Laundry Journal ...	London
Ldry. Rec. ...	Laundry Record ...	London
Lghtng.... ...	Lightning	London
Lt. Ry. & Tramw. Jr.	Light Railway and Tramway Journal	London
Locom. Engrg.	Locomotive Engineering	New York
Loc. Mag. ...	Locomotive Magazine	London
Machinery, London	Machinery	London
Machinery, New York.	Machinery	New York
Mach. Mark. ...	Machinery Market ...	London
Mftrr.	Manufacturer ...	Philadelphia
Mar. Engr. ...	Marine Engineer ...	London
Mar. Engrg. ...	Marine Engineering	New York
Mech. Engr. ...	Mechanical Engineer	Manchester
Mech. Prog. ...	Mechanical Progress	M'chr
Mech. Wrld. ...	Mechanical World ...	London
Metall.	Metallurgie	Paris
Miller	Miller	London
Mns. & Mnrls.	Mines and Minerals	Denver
Min. Journ. ...	Mining Journal ...	London
Ming. Wld. ...	Mining World ...	London
Mitt. a. d. Kgl. Tech. Versuchsanst, Berlin	Mitt. aus d. Kgl. Tech. Versuchsanst	Berlin
Mod. Machy. ...	Modern Machinery...	Chicago
Mois Scient. ...	Mois Scientifique ...	Paris
Motor Cr. Jr. ...	Motor Car Journal...	London
Nat. Ldry. Journ.	National Laundry Journal	Chicago
Nature	Nature	London
Nature, Paris ...	Nature	Paris
Naut. Gaz. ...	Nautical Gazette ...	New York
N. B. Agrilt. ...	North British Agriculturist	Edinburgh
Oest. Monatsschr. f. d. Oeff. Baudienst	Oest. Monatsschr. f. d. Oef' Baudienst	Vienna
Oest. Zeitschr. f. Berg u. Hüttenwesen	Oest. Zeitschr. f. Berg und Hüttenwesen	Vienna
Power	Power	New York
Pract. Engr. ...	Practical Engineer...	London
Proced. Am. Soc. Civ. Engrs.	Proceedings, Am. Soc. of Civil Engineers	New York
Proced. Engrs. Club	Proceedings of the Engineers' Club of Philadelphia	Philadelphia
Pub. Hlth. Engr.	Public Health Engineer	London
Rld. Gaz. ...	Railroad Gazette ...	New York
Ry. Age ...	Railway Age	Chicago
Rail. Engr. ...	Railway Engineer ...	London
Rail. and Engng. Rev.	Railway & Engineering Review	Chicago
Rail. Mag. ...	Railway Magazine ...	London
Railw. Mast. Mech.	Railway Master Mechanic	Chicago
Rail. News ...	Railway News ...	London
Rail. Rcd. ...	Railway Record ...	London
Ry. Sup. Jr. ...	Railway Supplies Journal	London
Rev. Min. ...	Revista Minera ...	Madrid
Rev. Tech. ...	Revue Technique ...	Paris
Rev. d. Chim. Ind. ...	Revue de Chimie Industrielle	Paris
Sch. Mines Qtly.	School of Mines Quarterly	New York
Science Abstr....	Science Abstracts ...	London & New York
Sci. Am. ...	Scientific American	New York
Sci. Am. Suppl.	Scientific American Supplement	New York
Shpng. Wrld.	Shipping World ...	London
South Afr. ...	South Africa... ...	London
Stahl u. Eisen..	Stahl und Eisen ...	Dusseldorf
Steamsh. ...	Steamship	Leith
Stevens' Inst. Ind.	Stevens' Institute Indicator	New York
Stone	Stone	New York
St. Ry. Inter. Jr.	Street Railway International Journal	New York
Survr.	Surveyor	London
Syr.	Syren	London
Tech. Qtly. ...	Technology Quarterly	Boston
Text. Ind. ...	Textile Industries ..	Bradford
Text. Merc. ...	Textile Mercury ...	Manchester
Text. Rcdr. ...	Textile Recorder ...	Manchester
Text. Ztg. ...	Textil-Zeitung ..	Berlin
Tramw. and Railw. Wld.	Tramway & Railway World	London
Trs. Am. Soc. M. E.	Transactions of the American Society of Mechanical Engineers	Cincinatti
Trs. Inst. Nav. Arch.	Transactions of the Inst. of Naval Architects	London
	Trans. Inst. Engrs. & Shipbuilders	Glasgow
Trs. N. E. Inst. Engrs. and Shpbldrs.	Transactions of the N. E. Coast Institution of Engineers and Shipbuilding	Newcastle
	Trans. Soc. Engrs.	
Un. Ser. Mag.	United Service Magazine	London
West. Electn. ...	Western Electrician	Chicago
Ztschrft. d. Oest. Ing. u. Arch. Ver.	Zeitschr. d. Oest. Ing. u. Arch. Vdr.	Vienna
Ztschrft. d. Ver. Deutsch. Ing.	Zeitschr. d. Ver. Deutscher Ingen.	Berlin
Ztschrft. f. Elektrochem.	Zeitschrift für Elektrochemie	Halle a. S.
Ztschrft. Elektrotech.	Zeitschrift für Elektrotechnik	Halle a. S.

ARCHITECTURE AND BUILDING.

1. Construction and Design.

Arches—*A Massive Foundation Arch.* Description of 32 ft. heavy brick arches, constructed to support a heavy building on the line of large water mains. 1⅛ col. —*Engrg. Rcd.*, June 23rd, 1900.

Construction.—*Relation between Transverse and Crushing Strength of Timber.* Concise notice regarding the highly important experiments carried out in the United States, under the direction of Dr. Fernow, Chief of the Division of Forestry in the United States. These tests were carried out by Prof. C. A. Martin and Mr. George Young, jun., of Cornell University, under the auspices of Prof. Roth, of the New York State College of Forestry, and established the very interesting and useful fact that the strength of a beam at the elastic limit is equal to the strength of material in compression to the point of failure. The practical value of this discovery is that a simple test in compression gives directly the answer to the important question of the strength of beam to safe limit. ½ col.—*Sci. Am.*, July 7th, 1900.

—— *A Few Principles of Ornament.* By W. H. Sargent. A concise but very instructive little article, containing practical suggestions for ornamentation. (Ill.) 1½ col.—*Am. Machy.*, Aug., 1900.

Electric Tower.—*The Pan-American Electric Tower.* Description of the so-called "Electric Tower" having a height of 375 ft., which will be the central feature of the Pan-American Exhibition, to be opened in Buffalo, N.Y., U.S.A., next year (1901), and in which $5,800,000 are to be invested. (Ill.) 3 cols.—*Engrg. Rcd.*, July 21st, 1900.

Exposition Buildings.—*The Exposition of* 1900. *The Palaces at the Esplanade des Invalides.* The article gives a concise description of the Palace of National Manufactures, and of the different Palaces containing the exhibits of furniture and the products of various industries connected therewith. (Ill.) 5¾ cols.—*Génie Civil*, Aug. 4th, 1900.

—— *The Exposition of* 1900—*Palace of Electricity.* The author, M. Réné Weil, describes the Palace of Electricity in the background of the Champ de Mars complex of buildings, which, together with the Water-Palace in front of it, forms a quite unique structure, and describes the various stages of its erection. (Ill.) 10 cols.—*Génie Civil*, Sept. 1st, 1900.

—— *The Palace of Illusions.* Description of a very original feature, bearing the above name, recently opened to the public, and occupying a position on the Paris Exhibition ground midway between the Electricity Palace and the Hall of Festivals, the illusory effects being due to specially arranged mirrors. (Ill.) 3 cols.—*Génie Civil*, Aug. 4th, 1900.

Chimney Construction.—*The Chimney of the Metropolitan Street Railway Company's Power House.* By William Wallace Christie. The article gives a fairly full description of what is probably the highest chimney in the United States. 1¾ col.—*Rld. Gaz.*, June 23rd, 1900.

Iron Structures.—*The Schneider Pavilion at Paris.* Description of the structural details and the building of the Creusot Pavilion by Messrs. Schneider & Co. in Paris, in a line with the Avenue de le Bourdonnais; the structure being a huge dome, with a campanily 41 metres (134 ft.) in diameter. (Ill.) 6⅜ cols.—*Engrg.*, Aug. 25th, 1900.

Reconstruction.—*Rebuilding the Kansas City Convention Hall.* The article describes the *modus operandi* for erecting the 187 ft. arches of the building above mentioned in a very short space of time. 1½ col.—*Engrg. Rcd.*, June 23rd, 1900.

Theatre Building.—*The Folly Theatre, Brooklyn.* Description of a theatre in course of construction at Brooklyn, N.Y., U.S.A., at the cost of $150,000, on a 100 by 150 ft. corner lot, which is interesting in so far as it is the first theatre building constructed under the new building laws of Greater New York. (Ill.) 3¼ cols.—*Engrg. Rcd.*, Aug. 11th, 1900.

2. Heating and Ventilation.

Heating and Ventilating.—*Heating and Ventilating Fan Systems.* Description of the heating and ventilating systems installed by the Buffalo Forge Company, of Buffalo, N.Y., U.S.A., based on the principle that the purification of the air in buildings is effected, not wholly in itself by the removal of vitiated air and the substitution of fresh, as is generally believed, but by the simple process of dilution and diffusion of gases, whereby the introduction of fresh air into a body of impure air acts simply to reduce the percentage of harmful constituents in the resulting combination to a point consistent with hygienic requirements. (Ill.) 1¼ col. *Am. Mftrr.*, Aug. 23rd, 1900.

—— *Hot Water Heating in Industrial Works.* By Alton D. Adams. The author points out that many industrial works generate very large amounts of heat in their power plant: and as matters stand, only from 10 to 15 per cent. of this heat is changed into mechanical work, while the remainder is wasted, which might be employed for useful work, such as heating the works. 5¾ cols.—*Cassier's Mag.*, Aug. 1900.

—— *The Vacuum System of Low-pressure Steam Heating.* By E. G. Rivers. Extracts from the Proceedings of the Institute of Civil Engineers. The author gives an account of the evolution of steam heating in the United States, and describes in a somewhat more detailed fashion the latest developments of low-pressure heating upon the vacuum system. 2¾ cols. *Mech. Wrld.*, Aug. 17th, 1900.

—— *Steam Heating in a Tall Brooklyn Office Building.* Description of a steam-heating plant, distinguished by a number of novel and interesting features, and laid down for the purpose of heating the Temple Bar office buildings, fourteen stories high, in the city of Brooklyn, N.Y., U.S.A. (Ill.) 2¾ cols. *Engrg. Rcd.*, Aug. 4th, 1900.

—— *Ventilation and Heating of the Law School Building, University of Pennsylvania.* The article deals with a heating and ventilating plant on the plenum system, the heating being secured by a heated supply of fresh air, and the whole arrangement being distinguished by a number of novel and interesting features. 4½ cols. *Engrg. Rev.*, June 16th, 1900.

3. Plumbing and Gas Fitting.

Stone Arch Bridges.—*New Double* 140 *ft.-Span Arch Bridge for the Fitchburg R.R. at Bellows Falls, Vt., U.S.A.* Description of a highly-interesting stone arch railway bridge in the United States, and the method of its construction. 1¾ cols.—*Engrg. News*, June 21st, 1900.

4. Miscellaneous.

Building Stones.—*British Building Stones I. Oolithic Limestones of Jurassic Age.* By Prof. Edward Hull, F.R.S. The author discusses the range of the Jurassic Formation in the British Isles, their structure and composition, the divisions that produce building stones, Portland stone, Base Bed, or Lower Tier, Whit Bed, the Corraline Oolite, the Bath Oolite, and the so-called Inferior Oolite. (To be continued). 3¾ cols.—*Stone Trds. Journ.*, Aug., 1900.

Cement Works.—*The Virginia Portland Cement Company's Works.* By Watson Vredenburgh, jun., C.E. Description of a thoroughly modern plant. (Ill.) 5 cols. —*Engrg. Rcd.*, July 28th, 1900.

Mosaics.—*Mosaic Paving.* By Arthur T. Bolton, A.R.I.B.A. Very interesting sketch of the history of mosaic paving, its use by the ancients, the material used, the appropriateness of this form of decorations, and hints of value to the student of architecture. 2¼ cols. (Ill.)—*Stone Trds. Journ.*, Aug., 1900.

Timber Seasoning.—*A Proposed Method for the Preservation of Timber.* By F. A. Kummer. Abstract of a paper read before the American Society of Civil Engineers, describing a number of experiments undertaken with the object of ascertaining the best methods of creosoting, accompanied by a general discussion of the causes of decay, which must be taken into consideration in order to prevent it. 3¾ cols.—*Engrg. Rcd.*, June 7th, 1900.

CIVIL ENGINEERING.

1. Bridges.

Bridge Designs.—*The Prize Designs for the Proposed Memorial Bridge Across the Potomac River at Washington, D.C., U.S.A.* Digest of the Report on these designs submitted by the board appointed for their examination. 1¾ cols. (Ill.)—*Engrg. News*, June 21st, 1900.

Bridges.—*The Lift, or Bascule, Type of Movable Bridges.* The author points out that in the opinion of many the existing cantilever bridges are considered to be, though somewhat unjustly, the ugliest structures imaginable; but the oldest form of movable bridge, the vertical swing, or bascule, bridge, which is gradually becoming popular, satisfies both practical and æsthetic requirements. 1¾ col.—*Engrg. Rev.*, July 28th, 1900.

—— *Repairing a Bridge Pier by means of an Annular Pneumatic Caisson.* By Mr. Edward M. St. John. Digest of an article by the author in the 1900 "Technic" of the University of Michigan Engineering Society, in which the author describes the ingenious way of repairing a pivot pier. The necessity of reparation was caused as follows:—Two of the bridges across the river at Little Rock, Ark., U.S.A., are owned by the St. Louis Iron Mountain and Southern Railway Company. One of these consists of four fixed through Pratt truss spans, and one swing span, making altogether about 1,200 ft. of bridge. The piers are of stone masonry, resting on timber caissons sunk to the rock about 45 ft. below water line. Shortly after being built the pivot pier, holding up the swing pier, and one other pier began to lean up stream. Temporary remedies were of no use, and finally the Missouri Valley Bridge and Iron Works undertook the repairing, which offered special difficulties, and is described in this article. (Ill.) 2¾ cols.—*Engrg. News*, Aug. 2nd, 1900.

—— *German Bridge-building Exhibits at the Paris Exhibition.* The article deals with the highly interesting joint exhibit of the six leading firms in Germany devoted to the design and construction of metallic bridges, organised after a conference of German bridge-builders at Frankfort-on-Main, May, 1898, where it was arranged to illustrate the entire field of German bridge construction by paintings, models, pamphlets, catalogues, working drawings and photographs, and above all by publishing a special work in German, French, and English, dealing with the evolution of the theory and design, manufacture and construction of metallic bridges in Germany. This work is a valuable treatise on the subject, entitled "A Hundred Years of German Bridge-building," and written by a high authority on engineering, Prof. George C. Mehrtens, of Dresden. 6½ cols.—*Engrg.*, Aug. 10th, 1900.

Pratt Type Bridge.—*New Skunk River Bridge, C. B. and Q. Ry.* The article describes a double-deck bridge, having three main spans of 146 ft. length of the Pratt truss type, the trusses being 36 ft. 6in. deep, raising the track to a height of about 68 ft. above low-water level. (Ill.) 1¼ col.—*Ry. & Engrg. Rev.*, June 9th, 1900.

Rolling Lift Bridge.—*A Rolling Lift Bridge at Cleveland.* Description of a rolling lift bridge of the Scherzer system and of the single arm type being built at Cleveland, O., U.S.A., by the C.C.C. & J. Ry. to take the place of an old wooden swing span structure. (Ill.) 1½ col.—*Ry. Age*, June, 1900.

Swing Bridge.—*The Spuyten Duyvil Swing Bridge, New York Central and Hudson River R.R.* Description of the bridge and outline of the method of construction. 1½ col.—*Engrg. News*, June 14th, 1900.

—— *Swing Bridges over the River Weaver at Northwich.* By J. A. Sauer. Description of a group of bridges over the river Weaver in Cheshire, so as to leave open a waterway of sufficient width for the important river traffic in the service of the salt and alkali industries, and permit the access of small coasting vessels. (Ill.) 3¾ cols. (To be continued.)—*Mech. Wrld.*, Aug. 24th, 1900.

Dry Docks.—*Dry Dock Construction.* The article comments on the use of concrete steel and its superiority as a material for dry dock construction. 1½ col.—*Engrg. Rcd.*, June 16th, 1900.

2. Canals, Rivers, and Harbours.

Canals.—*The Completion of the Marne and Saone Canal.* By G. Længuy. The author draws attention to the fact that this canal is in so far special interest, as the French Government, for the first time in the history of inland navigation, addresses itself to a Chamber of Commerce, that of Saint Dizier, inviting its participation in the completion of the canal, and then proceeds to describe some of the details of the work required and the character of the understanding arrived at between the State and the above-named Chamber of Commerce. (Ill.) 6¼ cols.—*Rev. Tech.*, Aug. 10th, 1900.

Dams.—*Soundings and Measurements at the Break in the Austin Dam.* By Thomas N. Taylor. The writer gives an account of the soundings made by him in order to ascertain the condition of the structure on June 9th. (Ill.) ¾ col.—*Engrg. News*, June 21st, 1900.

Drainage Canal.—*Final Report of the Special Commission on the Chicago Drainage Canal.*—Digest of a report of an investigation made in compliance with the Act of 1889 of the Illinois Legislature under which the construction of the Chicago Drainage Canal was undertaken, and which required that before the canal was opened it should be inspected by a special commission on behalf of the State of Illinois, which should certify to the Governor, that the work had been carried out in accordance with the Act, in which case the Governor should authorise the admission of water and sewage into the canal. 3 cols.—*Engrg. News*, Aug. 9th, 1900.

Pier Sheds.—*A large Steel Pier Shed.* Description of one of a number of steel pier sheds on the New York shore of the North River, which was built for the White Star Line at Pier 49, and was recently finished, consisting of a rectangular two-story structure 736 ft. long, 120 ft. wide, and 60 ft. high to the top of the ventilator, standing on a heavy timber deck supported by piles. (Ill.) 5¾ cols.—*Engrg. Rcd.*, July 28th, 1900.

Ports.—*The Ports of Tunis.* By G. Lenguy. The author gives a very interesting description of the engineering work in the maritime ports of Tunis and Susa finished last year, and doing credit to French enterprise through which Tunis, which some years ago had not a single navigable harbour, has obtained four, *i.e.*, Bizerta, Sfax, and the two above named. (Ill.) 7 cols.—*Revue Technique*, July 25th, 1900.

River Pollution.—*Improvement of the Mersey and Irwell Rivers.* The article gives a historical summary of the various measures and arrangements during a course of eight years, serving the object of keeping sewage and manufacturing wastes out of the rivers. 1¼ col.—*Engrg. Rcd.*, June 9th, 1900.

3. Irrigation.

4. Miscellaneous.

Excavators.—*Smulders' Excavators.* Description of the fine display of Messrs. A. F. Smulders, of Rotterdam, Holland, consisting of models and drawings of various types of excavators and dredging machinery; the article describes more fully a bucket and suction dredge built by this firm for marine dredging at Port Arthur, and an excavator constructed for irrigation works in the valley of Solo, Java. (Ill.) 1½ cols.—*Engrg.*, Aug. 3rd, 1900.

Hydraulic Work.—*Hydraulic Pile-Screwing.* By C. W. Anderson. Abstract of a paper read before the Institute of Civil Engineers, describing hydraulic motors employed for screwing piles into hard material, and describing the results obtained by these machines. 2¼ cols.—*Engrg. Rcd.*, June 16th, 1900.

Road-Building.—*Qualities of Good Road Metals.* This is a reproduction of an article by Mr. Harry Fielding Reid, from Stone, U.S.A., and contains an interesting inquiry into the essential qualities of a good road surface, and the best means of counteracting the effect of the forces tending to destroy roads. 2 cols.—*Stone Trds. Journ.*, Aug. 19th, 1900.

Viaducts.—*The Riverside Drive Viaduct, New York.* Description of a viaduct having a length of 1,800 ft., a width of 80 ft., and a height of 80 ft. above the grade of Twelfth Av., New York, which crosses

Manhattan Valley, will connect Riverside Drive with the Harlem River speedway, and complete a high-level boulevard forming part of a 10-mile system of driveways, along the banks of the Hudson and Harlem Rivers. The approaches are of ashlar-faced masonry, and the superstructure between them consists of twenty-two 65-ft., three 18-ft., and one 130-ft. steel arch spans, (Ill.) 6½ cols.—*Engrg. Rcd.*, Aug. 25th, 1900.

ELECTRICAL ENGINEERING.

1. Electro-Chemistry.

2. Electric Lighting.

Electric Lighting Plant.—*Electric Lighting at Rothesay.* Description of the new electric lighting at Rothesay, a Royal borough, which is the most important of the many beautiful resorts for which the Clyde estuary is famous. The contractors were Messrs. Lowdon, Bros. & Co., of Temple Electric Works, Dundee, whose offer was £2,500, exclusive of trenching and foundation work, while the total cost came to about £3,000. 2½ cols.—*Elec. Engr.*, Aug. 3rd, 1900.

Electric Lighting.—*The Ferranti Arc Light System.* Description of the Ferranti apparatus in its present improved form, mainly dealing with the Rectifier consisting of a constant current converter, a synchronous motor, and a high-tension commutator, driven at synchronous speed by the motor. (Ill.) 4 cols.—*Lightning*, Aug. 30th, 1900.

—— *The Leigh Electric Lighting Works.* Description of the recently-completed plant which is under control of Mr. John Foster, the manager of the Gas, Water, and Electricity Department, and consists of two Lancashire boilers, 30 ft. long by 8 ft. 6 ins. diameter, fitted with Musgrave's Superheaters and two sets of Green's Economizers; the generating plant at present comprises two coupled sets, one set consisting of a Willans & Robinson two-crank compound engine, coupled to a Mather & Platt four-pole shunt-wound dynamo, rated at 200 amps., 460 volts; the second set consists also of a Willans & Robinson two-crank compound engine with two Mather & Platt four-pole shunt-wound dynamos, one at each end of the crankshaft, and each giving 135 amps. at 300 volts, this set being used at present for charging the battery and for balancing. At present the engines are running non-condensing, but they can, with a slight alteration, become condensing, if required. (Ill.) 1½ col.—*Elec. Rev.*, Aug. 31st, 1900.

—— *The "Loftus" Patent Lamp.* Description of a lamp invented by the late Capt. Loftus, and manufactured by Messrs. Boxendale & Co., Miller Street, the special features of which consists in the form of the panes, that are so cut as to be powerful reflectors, and, being transparent, distribute the light everywhere, throwing it twice the distance of that given out by the ordinary lamp. (Ill.) 1 col.—*Mar. Engr.*, Sept. 1st, 1900.

3. Power.

Electric Power Plant.—*The Power-Generating Plant at the Paris Exhibition.* Description of the great power plant of the Paris Exhibition, which represent a total amount of electric energy of 30,000 h.p., furnished by 38 generating groups, while the total capacity of the steam-engines employed is about 38,000 h.p. (Ill.) 1½ col.—*Sci. Am.*, Aug. 4th, 1900.

—— *Exposition of* 1900. *Electric Generating Unit of the Augsburg-Nuremberg and of the Helios Society.* The article gives a concise description of the above-named German exhibits, and is accompanied by illustrations showing the plant completed and in the course of construction. 5 cols.—*Génie Civil*, July 28th, 1900.

—— *Electrical Engineering at the Paris Exhibition. No. III.* Description of the exhibits of the Helios Company of Germany, mainly represented by a large Helios machine running at 70 revolutions a minute, and developing 2,000 volts and 1,000 amps. as an ordinary alternator, or 500 amps. in three circuits, as a three-phase generator. (Ill.) 1½ col.—*Engr.*, Aug. 17th, 1900.

Electric Power Plant.—*The Paris Exhibition.* Description of the exhibit of Messrs. W. Lahmeyer & Co., of Frankfort-on-Main, Germany, consisting of a 1,500 h.p. compound steam-engine, running at 94 revolutions per minute, and two dynamos, one for 1,000 kilowatt, three-phase current at 5,000 volts, the other for 400 kilo-watt maximum at 300 volts. 2 cols.—*Elec. Engr.*, Aug. 10th, 1900.

—— *The Paris Exhibition Electric Power Station. The Laval Steam Turbines.* Description of the very interesting exhibit of the Laval Steam Turbines, by the Laval Company, consisting of two turbines, driving 10 Bregnet continuous current dynamos of 250 volts. 1¼ col.—*Engrg.*, Aug. 3rd, 1900.

—— *The Paris Exhibition Electric Power Station.* Description of an interesting and important unit of the French Electric Power Station at the Exhibition, being that of the *Compagnie Générale d'Electricité de Creil*, a branch recently established of the great firm of French contractors, Messrs. Daydé, Pillé, & Co., and of MM. Weyher & Richmond. This unit develops 1,000 h.p. in the form of a continuous current of 250 volts at 2,700 amps. (Ill.) 1 col.—*Engrg.*, July 27th, 1900.

—— *The Paris Exhibition Electric Power Station.* Description of one of the largest examples of British engineering, *i.e.*, that of Messrs. Galloway, Ltd., Manchester, consisting of six of their well-known patent "Galloway" boilers, and a vertical compound inverted engine in conjunction with the electric generator supplied by Messrs. Mather & Platt, Ltd., capable of developing 600 electrical h p. 1 col.—*Engrg.*, Aug. 17th, 1900.

—— *Electric Generating Unit of* 1,000 *h.p. by Escher-Wyss & Co., of und Oerlikon.* Description of an electric generating unit consisting of a 1,000 h.p. Corliss engine, built by Messrs. Escher-Wyss & Co., of Zurich, coupled with a dynamo of 1,300 kilowatts, built at the Oerlikon Works, Switzerland. (Ill.) 1½ cols.—*Génie Civil*, Sept. 1st, 1900.

—— *The Electric Generating System of Prague.* By Fred. Bathurst, A.M.I.E.E. Description of the new electric generating station at Prague, Bohemia, which has been in operation for about six months, and is perhaps the first three-phase high-pressure alternating works on a large scale which undertakes to supply simultaneously, and from a single set of bus bars, the electrical energy required for running tramways, providing an electric motor service, and the lighting of public and private buildings. (Ill.) 3 cols. (To be continued.)—*Elec. Rev.*, Aug. 17th, 1900.

—— *The Triphase Electric Company's Plant at Asnères.* This is mainly an abstract, in English, of an article recently published by the *Génie Civil*, describing the interesting plant, combining efficiency, economy, and security, recently laid down in this well known little village near Paris. (Ill.) 4½ cols.—*Engrg. Rcd.*, Aug. 11th, 1900.

—— *The La Bella Power Plant, Goldfield, Colo.* The article describes a power-plant erected to supply electricity within a radius of 6 miles, and compressed air within a radius of 2 miles, not to speak of water-power for the ore-washers near the power station, which is capable of supplying 3,600 h.p., and contains some interesting features. (Ill.) 3½ cols.—*Engrg. Rcd.*, June 2nd, 1900.

—— *Stockport Electricity Works.* Description of the Stockport Municipal Electricity Works, built according to the plans of Mr. J. N. Shoolbred, of London, a sum of £48,000 having been authorised, of which £25,000 have so far been spent, while a special loan will be required for the tramways. 2½ cols.—*Elec. Rev.*, Aug. 17th, 1900.

Electrical Transmission.—*Regulation in Long Distance Transmission.* Abstract of a paper by Fred. A. C. Perrins, D.Sc. Abstract of a paper read at the Tamalpais Meeting of the Transmission Association, U.S.A., in which the author calls attention to the difficulties of maintaining constant the periodicity of the alternating current supply by connecting regulators with the water-wheels, which will secure a constant speed of running regardless of the load, of regulating the voltage of the generators, which must vary with the varying

load; of keeping the line in good condition, and of finally adjusting in the sub-stations the voltage so as to suit customers; he suggests, at the same time, solutions to solve such difficulties as may be presented, without trying to offer the definite solution of any particular case. 7 cols.—*Journ. Elec. Power and Gas*, July, 1900.

Electrical Transmission.—*Transmission System Regulation.* By Prof. G. L. Cory. The author points out that the problems connected with the long-distance transmission of power have assumed a different character as the distance of transmission has been increased, with a corresponding increase in voltage, and then proceeds to illustrate the problem and its solution, taking as an illustration the conditions of the transmission of approximately 10,000 kilo-watts over a distance of 150 miles, terminating in San Francisco, which transmission is actually being constructed at present by the Standard Electric Company of California. 12½ cols.—*Journ. Elec., Power and Gas*, July, 1900.

—— *Application of Storage Batteries.* By C. O. Poole. After a few introductory remarks on the subject, the author discusses the three most important points that confront the central station manager, namely, good regulation, an uninterrupted service, and a good load factor, all three of which the storage battery assists very materially in securing. 5½ cols.—*Journ. Elec., Power and Gas*, July, 1900.

—— *Regulation in Long-Distance Transmission.* By Fred. A. P. Perrins, D.Sc. Abstract of a paper read at the Fourth Annual Transmission Convention, held at Mount Tansalpais, Cal., June 19-20, 1900. 4½ cols.—*Electricity* (New York), Aug. 22nd, 1900.

—— *Electric Power in Cripple Creek District.* By J. W. Dickarson. Description of the great abundance and excellence of the electrical equipment of the mines in this famous gold region of the United States, which enjoys many of the advantages of civilisation missing in great cities even. (Ill.) 3 cols.—*Mod. Machy.*, Aug., 1900.

—— *Limits of Electric Transmission.* By Alton D. Adams. The author criticises the view of those who foretell a constantly increasing use of electric power transmitted from some distant place, for natural power can be obtained cheap or even gratis, to some other places where it will fetch a high price, and who believe that there is scarcely any limit to the possibilities of electric transmission. He endeavours to demonstrate that if absolutely free fuel could be had at a point 100 miles from some of our great cities, the electric transmission of steam-generated power from this fuel to the cities would involve a yearly loss per delivered horse-power of more than 8·39 dollars. 2 cols.—*Sci. Am.*, Aug. 25th, 1900.

Motors.—*The Development of the Induction Motor.* The article reviews the historical development of electric motors, and gives a general description of the Tesla Polyphase Induction Motor as built by the Westinghouse Electric and Manufacturing Company. (Ill.) 4½ cols.—*Engr.* (Cleveland), Aug. 1st, 1900.

—— *Alternating Induction Motors.* By A. C. Eborall. Abstract of a paper read before the Institute of Electrical Engineers, containing some practical hints regarding the construction, design, and performance of modern single-phase and polyphase induction motors, and a review of some recent developments in this branch of engineering. (Ill.) 6 cols., 4¾ cols., and 5 cols. respectively.—*Mech. Engr.*, Aug. 4th, 11th, and 25th, 1900.

Transformers.—*Design for a Simple Transformer in Four Sizes.* By Cecil P Poole. The author describes a type of transformer that can be built by any amateur without the use of machine tools or special apparatus, except some form of winding machine; the core is made of an unusual type, involving the use of rectangular strips of iron. (Ill.) 5 cols. (To be continued.)—*Mech. Wrld.*, Aug. 10th, 1900.

4. Telegraphy and Telephony.

Cables.—*Insulated Cables at the Paris Exhibition.* The article attempts to deal separately, *i.e.*, without more than passing reference, to the applications of electricity in general, with the subject of insulation, and points out that to France and Italy must be accorded the palm of merit as regards the extent and general interest of the exhibits of this branch of the gutta percha trade at Paris, that England, except for Silvertown of the Persan-Beaumont Works was unrepresented, and that America shows up very badly, being represented by one insignificant exhibit only. 3¾ cols.—*Engrg.*, July 27th, 1900.

Telegraph.—*A Type-Writing Telegraph.* Description of a telegraph invented by Mr. Donald Murray, of New York, being an improved form of the page printing telegraph, and employing an ordinary form of type-writing machines. The invention combines a recording instrument, having a series of independently movable character levers, an electro-magnetic perforating instrument, and a tape of paper passing through both instruments in succession. ¾ col.—*Elec. Engr.*, Aug. 10th, 1900.

Page-Printing Telegraph.—*The Murray High-Speed Page-Printing Telegraph.* Description of an invention of Mr. Donald Murray, an Australian, the American patents of which have been acquired by the Postal Telegraph Co., of the U.S.A., giving a speed of 114 words per minute, over a distance of 388 miles. ⅝ col.—*Sci. Am.*, Aug. 11th, 1900.

Telephones.—*The Dardeau Direct-Call Telephone.* Description of the telephone system used for rapid communication all along the travelling platform at the Paris Exhibition, and in connection with the associated electric railways in Paris, constructed by the Société Industrielle des Téléphones, one of the largest establishments of its kind in France. 2 cols.—*Engrg.*, July 27th, 1900.

—— *Recording Telephones.* The article deals with two recent inventions for the purpose of recording telephonic messages, the "Telephonograph," invented by Mr. E. O. Krumberg, and the "Telegraphone," designed by Mr. Valdemar Poulsen, a Danish electrician, at present on view at the Paris Exhibition. (Ill.) 3¼ cols.—*Nature*, Aug. 16th, 1900.

5. Miscellaneous.

Dynamometer.—*A New Transmission Dynamometer.* By W. Elwell Goldsborough, Prof. of Electrical Engineering, Purdue University, Lafayette, Ind., U.S.A. Abstract of a paper read before the American Institute of Electrical Engineers, describing a dynamometer specially adapted for testing electric motors of from 5 to 25 h.-p. capacity. 1⅛ col.—*Engrg. News*, July 26th, 1900.

Electrical Applications.—*Applications of Electricity in the Collieries of Great Britain.* By Sidney F. Walker. An interesting, profusely illustrated article on the subject. 10 pp.—*Engrg. Mag.*, Aug., 1900.

Electrical Apparatus.—*Some Novel Inventions of Nicola Tesla.* The article deals with some of the minor inventions of this famous inventor, whose name is generally associated with high frequency and high potential currents, one of them being an electrolytic meter, anti-sparking brush devices, thermo-magnetic motors, etc. 3 vols.—*Elec. Engr.*, Aug. 10th.

Physical Laboratories.—*The Work of the Reichsanstalt.* The author deals with work carried on in the Imperial Institute (Reichsanstalt) at Charlottenburg, near Berlin, which is the most distinguished physical laboratory in existence in any country, and of special interest to English readers just at present, when our National Physical Laboratory is building, and its organisation will soon have to be decided upon. 3¾ cols.—*Engrg.*, Aug. 10th, 1900.

Electrically Driven Elevators.—*The Reno Inclined Elevator.* Description of an elevator in the shape of a moving inclined plane, constructed by the Reno Inclined Elevator Construction Syndicate, of 70, Finsbury Pavement, London, E.C. An American invention recently introduced into England, and to be seen at the Crystal Palace. (Ill.) 1¼ col.—*Elec. Engr.*, Aug. 10th, 1900.

Elevators.—*The Reno Inclined Elevator.* Description of a type of lift intended to do away with the necessity of climbing stairs and moving the passengers upward on an inclined plane. This lift, known as the "Reno Inclined Elevator," has been in use in many places in the United States, but has for the first time been introduced into England a few weeks ago in the Crystal Palace. (Ill.) 1¼ col.—*Engr.*, Aug. 10th, 1900.

Electric Meters.—*Electrical Measuring Instruments.* By J. Franklin Stevens. Abstract of a paper, read before the Franklin Institute, in which the author discusses the requirements of a satisfactory instrument, the various types of instrument, the hot wire instrument, the electrostatic instrument, etc. (To be continued.) (Ill.) 4 cols.—*Mech. Engr.*, Aug. 25th, 1900.

Electrical Phenomena.—*Sources and Properties of Bacquerel Rays.* G. H. Bryan. The article describes the gradual development of the inquiry into the phenomenon of the so-called Becquerel Rays, and enters into a short discussion of the more recent discovery in connection with these phenomena. 5 cols.—*Nature*, June 14th, 1900.

—— *Electrolysis in Providence, R.I.* Digest of a very interesting report, made by Mr. A. A. Knudson, M.Am.Inst.E.E., at the request of the Commissioner of Public Works of Providence, R.I., U.S.A., in order to ascertain the damage done by stray currents to the water-mains. (Ill.) 4¾ cols. *Engrg. Rcd.*, Aug. 4th, 1900.

Electricity.—*Some Remarks upon the Cause and Nature of Electric Force.* By R. C. Shettle, M.D. The author endeavours to demonstrate that matter was originally formed by the force of cohesion acting upon and condensing a primary stuff; that the residuum of that stuff (which did not undergo condensation into formed matter) constitutes the ether, and is the basis of electric force. 4¾ cols.—*Elec. Engr.*, Aug. 24th, 1900.

Switchboards.—*Modern Switchboard Practice.* By Mr. Frank C. Perkins. The author reviews the great advance that has been made within the last ten years in the construction of switchboards, especially in light and power plants, and the many changes that have been introduced in the apparatus for controlling and handling alternating current, all tending toward greater efficiency and simplicity. (Ill.) 7 cols.—*West. Elect'n*, Aug. 18th, 1900.

Switch Gear.—*The Evolution of Switch Gears for High-Pressure Alternating Currents.* By W. E. Warrilow. The author reviews the gradual but remarkably rapid evolution of the high-pressure switch gear, which has effected so complete a revolution that it often appears hardly credible that the older form had been in use within such recent times. (Ill.) 2 cols., 3¾ cols., 2 cols., 1¾ col. respectively. (To be continued.)—*Elec. Engr.*, Aug. 10th, 17th, 24th, and 31st, 1900.

Thermal Electricity.—*Production and Utilisation of an Electric Current by means of Steam.* By E. E. Stahl. The author, starting from the phenomenon that every time the steam of a little steam engine isolated from the earth is put into communication with the soil by means of an electrode, the tension of the steam immediately disappears and is restored on severing the connection, draws interesting conclusions from this fact with reference to the generation of electricity. 6 cols.—*Rev. Technique*, Aug. 10th, 1900.

Water-Power.—*New Wheel-pit at Niagara.*—By Orrin E. Dunlop. The author describes the excavation of the new wheel-pit at Niagara Falls, which has reached a depth of 75 ft.; operations are carried on night and day, and in all probability the contract will be completed by June, 1901. As the pit is to be carried to a depth of 180 ft., somewhat over 100 ft. are still to be excavated before the bottom is reached. (Ill.) 2½ cols.—*Sci. Am.*, Aug. 18th, 1900.

MARINE ENGINEERING AND SHIPBUILDING.

1. Merchant Vessels.

Steamers.—*The Newhaven and Dieppe Channel Steamer* "Arundel," built by Messrs. William Denny & Brothers, of Dumbarton, for the London, Brighton, and South Coast Railway Company's popular service to France. (To be continued.) 1½ col.—*Engrg.*, Aug. 17th, 1900.

—— *New Type Propeller Steamers.* Short description of the *Pennsylvania*, one of the new passenger boats navigating on Chesapeake Bay. 3 cols.—*Naut. Gaz.*, June 28th, 1900.

Steamers.—*The Hamburg-American Liner* "Deutschland." Description of this famous vessel, which is not the largest, but the fastest, most powerful, and best-equipped vessel on the Atlantic, built at the Vulcan Iron Works, Stettin, Germany. (Ill.) 2 cols.—*Sci. Am.*, Aug. 4th, 1900.

—— *Maiden Trip of the Hamburg-American s.s.* "Deutschland." Description of the maiden trip of this, the fastest steamer on the Atlantic. The contract called for a speed of 23 knots, and the first trip (as well as later trips) showed that this figure is being exceeded even. (Ill.) 2 cols.—*Mar. Engrg.*, Aug., 1900.

Freight Vessels.—*Steel Freighters* "Pleiades" *and* "Hyades," *for the Boston Towboat Company.* Description of two vessels of a type on which will depend largely the future of the American merchant marine—the ocean freighter, designed to carry freight in bulk, such as coal, grain, rails, etc., having a length over all of 350 ft., between perpendiculars of 330 ft. 6 in., beam moulded 47 ft., depth at side moulded 28 ft., sheer forward 8 ft., aft 3 ft., and a gross tonnage of approximately 4,000 tons. 3½ cols.—*Mar. Engrg.*, Aug. 1900.

2. Pleasure Craft.

Yachts.—*A Yacht that Sails Itself.* Description of a very ingenious, interesting, and successful attempt to produce a sailing yacht capable of going automatically through all the manœuvres of beating, reaching, and running, etc. By Mr. H. Consterdine, of Lancaster, England. (Ill.) 1½ col.—*Sci. Am.*, July 28th, 1900.

3. Equipment and Machinery.

4. Docks.

Docks.—*The Floating Dock as an Adjunct to a War Navy.* By Lyonel Clark, M.I.N.A. Abstract of a paper read before the International Congress of Naval Architects at the Paris Exposition, Paris, 1900. The author demonstrates the importance of a suitable floating dock for navies, adapted to the great variety of the vessels, and arrives at the conclusion that a modern naval dock should have a length of 750 ft., a beam of 100 ft., and a depth over the bottom of 47 ft. He then enters into a discussion of the technical details of construction of floating docks, the advantages of which he illustrates. (Ill.) 10½ cols.—*Engr's. Gaz.*, Sept., 1900.

5. Miscellaneous.

Dredgers.—"La Puissante"—*The Largest Dredger of her Class Afloat.* Description of a hopper dredger built by Messrs. William Simons & Co., Ltd., of Renfrew, having a hopper capacity of no less than 2,200 tons of dredging and a lifting capacity of 1,800 tons per hour. 1½ col.—*Mar. Engr.*, Aug. 1st, 1900.

Lighthouse Equipment.—*Paris Exhibition. Lighthouse Engineering.* The article is mainly devoted to the description of the most important lighthouse exhibit of the Paris Exhibition, that of the *Service des Phares* in the Musée du Dépot de Phares, and of three well-known Parisian manufacturers, Barbier et Benard, Saulter-Harlé & Cie., and the Société Henry Lepante. (Ill.) 4 cols.—*Engr.*, Aug. 10th, 1900.

Piers.—*Concrete Pier Superstructure for the New Ship Canal Entrance to Duluth Harbour, Minn., U.S.A.* Description of the final designs for the new ship canal entrance, accompanied by drawings showing cross sections of the main pier at two points, and one the pier head. (Ill.) 5 cols.—*Engrg. News*, July 26th, 1900.

Shipbuilding.—*Unique Engineering Feat.* The article records the incidents of the rapid work of cutting the steamship *Indiana* in two, and drawing the sections apart to a distance of 40 feet. 1½ col.—*Naut. Gaz.*, June 14th, 1900.

—— *The Shipbuilding Yards of the United States.* By Waldon Fawcett. The article deals with the Harlan and Hollingsworth Company's Yard, at Wilmington, Del., U.S.A.; the Roach Ship Yard, at Chester, Pa.; the Neafie and Levy Ship and Engine Building Co.'s yard at Philadelphia; several yards at Bath, Me., and

neighbouring ports; shipbuilding plants in the vicinity of Boston, some other yards on the Atlantic coast, and, omitting the Union Ironworks, in San Francisco, describes the Wolff and Enviller Ironworks, of Portland, Oregon, on the Pacific, as well as a number of shipyards on the Great Lakes. (Ill.) 8 pp.—*Engrg. Mag.*, Aug., 1900.

Shipbuilding.—*Practical Results of some Practical Innovations in Modern Shipbuilding.* By Henry B. Wortley. Abstract of a paper read before the Institution of Naval Architects, London, describing some innovations introduced in eleven steamers owned by the Ocean Steamship Co. (Ill.) 8 cols.—*Mar. Engrg.*, Aug., 1900.

MECHANICAL ENGINEERING.

1. Boilers, Furnaces, and Fuel.

Blast Furnaces.—*A New Method of Constructing Blast Furnaces.* Abstract of a paper read by Mr. F. Burgers, of Gelsenkirchen, Germany, before the "Verein Deutscher Eisenhüttenleute, describing a new method of constructing blast furnaces, special in its application to the shaft of the furnace, which is made of iron instead of refractory fire-brick. (Ill.) 2 cols.—*Ir. & Coal Trds. Rev.*, July 27th, 1900.

Boilers.—*A Word on Boiler-making.* By H. R. Barnhurst. The author discusses the principles of boiler construction, and dwells on the fact that it is important to construct boilers not only in such a manner as to be satisfactory in economy and regulation, but also so that they are reasonably safe from destructive explosions. 7 cols.—*Cassier's Mag.*, Aug., 1900.

Fuel.—*Petroleum Fuel for Warships.* By Alton D. Adams. The author deals with the advantages of petroleum as a fuel, which has not only a heating power 50 per cent. greater than that of coal for the same weight, but also for equal bulk. 1⅛ col.—*Sci. Am.*, Aug. 11th, 1900.

Mechanical Stokers.—*Mechanical Stokers at the Parkshead Forge.* Description of mechanical stokers on the Bennis system, with which all the boilers, *i.e.* 15 water-tube boilers of the Babcock and Wilcox system, and eight Lancashires, are fitted in the above-named ironworks. 1 col.—*Ir. & Coal Trds. Rev.*, Aug. 10th, 1900.

2. Compressed Air.

Air Compressors.—*Explosions in Air Compressors.* Extracts from some notes by Mr. E. C. Sickles, published in the *Sibley Journal of Engineering*, in which the author points out that during the past two years all the explosions which came under his attention took place in apparatus, or parts of apparatus connected to single stage compressors, compressing air from 11½ to 92 or 105 lbs. absolute, from which he infers that these pressures were used for which the apparatus was not adapted. 1 col.—*Engrg. Rcd.*, July 25th, 1900.

Compressed Air.—*Compressed Air for Transmission of Power.* By J. H. Ronaldson. Abstract of a paper read before the New South Wales Chamber of Mines, in which the author explains the principles connected with the subject, and the machinery employed for the purpose. 4½ cols.—*Austr. Min. Stand.*, July 26th, 1900.

3. Engines and Motors.

Automobiles.—*Capel's Motor Car.*—Description of a motor car that possesses many novel features, and was designed with the object of incorporating as many of the parts, essential for the propelling mechanism, into the frame itself, as is usefully possible; suspending the body and framework upon the axles in such a manner, as to be rigid laterally and flexible vertically; rendering the motor, in its action, as automatic as possible; condensing the variable transmission gearing into a small space; providing a sensitive steering gear; fitting the seats and the body of the car in such a manner that the whole mechanism is enclosed. (Ill.) 1¾ col.—*Autom. Journ.*, Aug. 1900.

Electric Automobiles in Boston.—The article deals with the general management and methods of operation of the New England Electric Vehicle Transportation Company, especially as regards the supply of electric energy. 3 cols.—*Elctr. Wrld. Engr.*, June 16th, 1900.

Automobiles. — *Automobile Imperfections.* By W. H. Booth. The author dwells on the many good qualities of the horse as compared with a mechanical device, and points out a great number of deficiencies of the automotor. 13 cols.—*Am. Mach.*, July 26th, 1900.

—— *Motor Competitions in France.* By G. Forrestier. Digest of reports on two competitions, which go to show that mechanical power for propelling vehicles is far more economical than horse-power, and promises to come into general use in the near future. 1½ cols.—*Am. Mftrr. and Ir. Wrld.*, May 31st, 1900.

—— *Front-Driven Motor Carriages.* By "Precursor." The author gives a description of the historical development of the idea of driving the front wheel or wheels of a motor vehicle, and its application to modern automobiles. (Ill.) 4 cols.—*Autom. Journ.* Aug., 1900.

—— *The Manufacture of Motor Cars.* The article dwells on a subject of equal weight in many branches of engineering, namely, the injury done to the trade by persons who begin the manufacture of novel machinery without being qualified to do so owing to their lack of technical education. 2½ cols.—*Autom. Journ.*, June, 1900.

—— *A Storage Battery Spark Ignition.* By Hugh Dolnar. Description of an ignition outfit adapted to the requirement of stationary motor uses, and consisting of two pairs of 5 amp.-hrs. storage cells, mounted on a slate panel. (Ill.) 4½ cols.—*Am. Mach.*, Aug. 9th, 1900.

—— *Messrs. Carel's High-Speed Vertical Engines.* Description of the exhibit of Messrs. Carel at the Paris Exhibition. This Belgian firm, having their works at Sclessin-Liège, had an exhibit of several engines, of which this article describes one of 210 i.h.p., coupled with a continuous current dynamo. (Ill.) 2 cols. —*Mech. Engr.*, Sept. 1st, 1900.

Motor Vehicles.—*Heavy Motor Vehicles for Road Service.* By Fred. M. Maynard. The article deals with heavy motor vehicles of all kinds, and their comparative advantages. It will be followed by a second contribution, dealing with the specific forms of motor waggon which have proved successful in Great Britain. 8 cols.—*Engrg. Mag.*, Aug., 1900.

Engines.—*High-Speed Vertical Triple Expansion Engine*, Central Electric Station, Vienna, Austria. Description of the triple expansion units of 1,500 h.p. to be installed by the Austrian General Electric Co., at their central station in the Leopoldstadt at Vienna. (Ill.) 1½ col.—*Engrg. News*, Aug. 2nd, 1900.

—— *Steam Fire Engine at the Paris Exhibition.* Description of a new pattern of steam fire engine, constructed by Messrs. Merryweather and Sons for the London Metropolitan Fire Brigade, of which an example is being exhibited by the firm at Paris. It is of the double-cylinder direct-acting type, with connecting-rod and crank motion. (Ill.) ¾ col.—*Engrg.*, Aug. 31st, 1900.

—— *Prime Movers at the Paris Exhibition. No. VII.* Description of an interesting horizontal engine exhibited running in the Champs de Mars Machinery Hall by the Belgian firm Carels Frères. (Ill.) 3½ cols. —*Engr.*, Aug. 17th, 1900.

—— *The Paris Electric Power Station.* Description of the exhibit of Messrs. Dujardin & Co., of Lille, consisting of two engines, one of which drives the dynamo exhibited by MM. Scheier & Co., of Creusot, and the other a generator of the Société d'Eclairage Electrique, the special feature being the valve-gear designed by M. Dujardin and bearing his name. 5⅝ cols.—*Engrg.*, Aug. 31st, 1900.

—— *Prime Movers at the Paris Exhibition. No. VI.* This instalment describes the combined exhibit of the firms formerly known as Cail & Co. and the French Thomson-Houston Co., consisting of an engine by the former company, now known as the "Société Française des Constructions," and a dynamo of the latter, being of 1,000 kilo-watt power for triphase currents. (Ill.) 2 cols. —*Engr.*, Aug. 3rd, 1900.

Engines.—*Machinery for the United States Navy Armoured Cruisers.* By Rear-Admiral G. W. Melville, U.S.N. The author states that the preliminary designs have been made, and he compares briefly their merits and demerits, one being a triple-screw arrangement with the wing-engines of about half the power of the centre screw, all placed abreast each other in the ship; the second representing the same arrangement as the first, except the centre engine, which is placed aft of the two wing-engines, the third, finally, being the ordinary twin-screw arrangements. 1⅜ col.—*Engr.*, Aug. 3rd, 1900.

—— *The Imperfections of the Cycles of Heat Motors—The Economical Motor.* By O. Duperrow. The author gives a general account of the theory of thermal engines, and then describes a motor designed by himself, in which an effort is made to unite the advantages of steam and gas engines. 7 cols.—*Génie Civil*, May 26th, June 2nd, 1900.

—— *Prime Movers at the Paris Exhibition. No. V.* This instalment deals with portable engines of German construction. In portable engines, which are one of the best known products of British industry in all parts of the world, not the Americans, but the Germans, are our real competitors, and a comparison is especially interesting, as there are striking contrasts between the two. One of our most serious rivals is Mr. Rudolph Wolf, whose works are at Buckaw, just outside of Magdeburg, to whose products the article is chiefly devoted. (Ill.) 2½ cols.—*Engr.*, July 27th, 1900.

—— *Experience with French Single Expansion Engines Fitted with Piston Valves.* Digest of a series of articles in the *Revue Générale des Chemins de Fer*, by M. Deadouits, engineer-in-chief of rolling stock and machinery of the French State railroads, giving the results obtained with four new single expansion engines fitted with Ricour piston valves running on the State lines. (Ill.) 4 cols.—*Mech. Engr.*, Aug. 25th, 1900.

—— *The Balancing of Engines.* By Macfarlane Gray. Abstract of a paper read before the Institute of Marine Engineers, May 14th, 1900. 4 cols. and 5 cols. respectively.—*Mech. Engr.*, Aug. 4th and Aug. 11th, 1900.

—— *Rolling Mill Engines and Mining Machinery at the Paris Exhibition.* Description of a reversing rolling mill engine, with three horizontal cylinders for direct train-driving, and a high-speed pumping engine, also with three cylinders, exhibited by Messrs. Ehrhardt & Schmer, Schlerfmühle, near Saarbrücken, Germany. 1½ col.—*Engrg.*, Aug. 17th, 1900.

—— *Reheaters in Multiple-Cylinder Engines.* By Prof. R. H. Thurston. Abstract of a paper presented at Cincinnati meeting of the American Society of Mechanical Engineers, in which the author demonstrates the value of the reheater, but points out at the same time, that a reheater can be of little use in improving the thermodynamic action of an engine, if it has not sufficient power to produce some superheating, and that even the most advantageously placed reheater is of small importance if supplied with wet steam. 4½ cols.—*Mech. Engr.*, Aug. 18th, 1900.

—— *The Campbell Oil Engine.* The article describes the construction, and mentions some details of oil engines constructed by the Campbell Gas Engine Company, of Halifax, which are in considerable favour owing to their efficiency. (Ill.) 3 cols.—*Mech. Engr.*, Aug. 18th, 1900.

—— *Some Prominent Engines at the Paris Exposition.* Descriptive article of the engine exhibits at the Paris World's Fair, the greater portion of which is devoted to a vertical engine in the Paris section, built by the Société Française de Constructions Mécaniques, and the vertical engine of A. Borsig, Germany. (Ill.) 14 cols.—*Power*, Aug. 1900.

—— *The Barnard Fanless Cooling Tower.* The article, after pointing out that the addition of a condenser to the average steam-engine required an artificial cooling apparatus when no running water supply is available, and that such a cooling apparatus was devised some years ago by the Wheeler Condenser Engineering Company, of 120, Liberty Street, New York, in the construction of the Barnard cooling tower, in which a fan was used, describes an improved Barnard tower without a fan. (Ill.) ¾ col.—*Engrg. Rcd.*, July 28th, 1900.

Gas Engines.—*The Use of Gas Engines in connection with Electric Power Plants.* By Philip Dawson. The author points out the progress made in the design of gas engines since the first commercially successful engine of that kind was placed upon the market by Messrs. Otto & Langen, some 25 years ago, and dwells on the fact that, at the present moment, under given conditions, the adoption of gas engines enables us to effect a great economy in the production of electrical energy; he then proceeds to discuss in a series of articles these conditions, and to critically examine, in the light of past experience, what the conditions governing the choice of gas-driven plant are, and what the hope for the future may be. (Ill.) 5½ cols., 9 cols., 5½ cols. respectively. (To be continued.)—*Engrg.*, Aug. 10th, 17th, and 24th, 1900.

—— *Blast Furnace Gas Engine.* Digest of the report recently published by M. H. Hubert. Professor of Mining at the Liége University, giving the result of tests conducted under his direction with the Delamare-Debouttéville and Cockerill 600 h.p. gas engine consuming blast furnace gas. (Ill.) 3½ cols.—*Mod. Machy.*, Aug., 1900.

Pumping Engines.—*The Nordberg Pumping Engine at Wildwood, Pa.* Extract from a paper by Prof. R. H. Thurston, of Cornell University, U.S.A., describing the tests made with and the construction of a pumping engine installed at Wildwood, Pa., for the Pennsylvania Water Company, by the Nordberg Manufacturing Company of Milwaukee, Wis., an engine which holds the world's record in efficiency, and was built to meet the most exacting conditions in regard to space and arrangement of parts. (Ill.) 5 cols.—*Engrg. News*, Aug. 23rd, 1900.

—— *Trial of an Allis Triple Expansion Pumping Engine, Chestnut Hill Station, Boston Waterworks.* Description of a contract duty trial made on May 1st and 2nd this year, with large engine built by E. P. Allis & Co., of Milwaukee, Wis., U.S.A., in 1897-98, and which began running in December of the latter year, being of the vertical triple-expansion self-contained type, with three single-acting outside packed plungers, having at contract speed about 17½ revolutions per minute, a capacity of 30,000,000 U.S. gallons in 24 hours. 3⅜ cols.—*Engrg. News*, Aug. 28th, 1900.

—— *Worthington Marine Pump Specialities.* Description of the Worthington Pavilion at the Paris Exhibition, which is one of the most noteworthy sights at this great show, and of the most interesting exhibits to be seen there. (Ill.) 2½ cols.—*Steamship*, Sept. 1900.

Pumps.—*Exhibition of* 1900. *Waterworks. Pumping Station of the French Worthington Pumps Company.* Description of the very important machinery for water supply at the Paris Exhibition. (Ill.) 7 cols.—*Génie Civil*, Aug. 18th, 1900.

—— *The Mammoth Pump.* Description of a type of pump constructed by the famous firm of A. Borsig, Berlin, and applicable to a great variety of purposes, the origin of this pump dating back to 1797, when Carl Emanuel Loöcher devised an "aërostatic apparatus, whereby without any bucket or pump-work whatever, water can be raised from a well to a height of some hundred yards" based on the principle of sinking a tube in the water with part of its length standing above the surface, and then forcing air through a smaller tube into the submerged orifice of the larger, whereby the air bubbles mixing with the water so reduced its specific gravity that by pressure of the external water the mixture flowed out at the top of the tube. 2½ cols.—*Mech. Wrld.*, Aug. 24th, 1900.

Traction Motors.—*Superheated Water Motor for Railroad Traction.* Description of a standard railroad car, now undergoing trials on the New York and Putnam Railway, which is equipped with a motor that is an interesting development of the class of engines operated by superheated water. (Ill.) 2 cols.—*Sci. Am.*, Aug. 25th, 1900.

4. Power and Transmission.

Cranes.—*Electric-Crane, with movable Base, constructed by Messrs. Mohr and Fedeshaff, of Mannheim.* The article describes a crane of German construction, which has been awarded the Gold Medal at the Paris Exhibition, and can be seen in working order every day at the Quai d'Orsay. It is connected with an electric three-phase generator of 200 volts, which supplies two electro-motors—one of 23 h.p. at 570 revolutions per minute, that furnishes the lifting power, while the other, of 4·5 h.p. at 940 revolutions per minute, serves for moving the turning gear. (Ill.) 2⅞ cols. *Revue Technique*, Aug. 25, 1900.

—— *A 150-ton Electric Cantilever Crane.* Description of a powerful crane, in course of construction by the Duisburg Machine Works, at Duisburg, Germany, for the Krupp Germania Wharf, at Kiel. (Ill.) ¾ col. *Mech. Engr.*, Aug. 25, 1900.

—— *A 25-ton Hydraulic Travelling Crane.* Description of a powerful crane, designed by Mr. Ernest W. Naylor, built by the Pennsylvania Iron Works Company, and recently put in operation in the Altoona shops of the Pennsylvania Railroad. It was installed for what is believed to be the largest hydraulic gap riveter ever built, which was also designed by Mr. Naylor. 2 cols. —*Am. Mach.*, Aug. 9, 1900.

Cranes.—*Electric Cranes in German Harbours.* By Louis J. Magee. The author gives a very interesting description of the construction and working of the many electric cranes used in Germany, and of their very extensive employment, especially in Hamburg. He states that early in the nineties electric cranes were tried and practically abandoned for the high speed of the motors. The mistake of trying to perform all movements with one motor, instead of having a motor for each movement, &c., were troubles just serious enough to outweigh the recognised advantages of electric power distribution, but at present "the motor has come down to the everyday, greasy, long-suffering existence of the steam engine." (Ill.) 12 cols.—*Cassier's Mag.*, Aug., 1900.

Dynamometer.—*A New Transmission Dynamometer.* By W. Ellwell Goldsborough. Description of an instrument for the measurement of mechanical power comparable with electrical instruments as regards simplicity of design, ease of calibration, permanency of adjustment, and accuracy of the readings obtained. 5 cols. *Mech. Engr.*, Aug. 11, 1900.

Transmission of Power.—*Step Bearings, Vertical Shafts, and Couplings.* Description of a kind of thrust, or step bearing, manufactured by P. Pryibil, New York, specially made for supporting vertical shafts in establishments where power is to be transmitted to upper floors, and it is desirable to avoid cutting belt holes through the floors. (Ill.) 1½ cols. *Am. Mach.*, Aug., 1900.

—— *Power Transmission by Shafting* v. *Electricity.* Abstract of a committee report, presented at the convention of the American Railway Master Mechanics' Association, by Messrs. George Gibbs, F. Mertsheimer, William Renshaw, W. A. Nettleton, and R. A. Smart, in which the following conclusions are arrived at: In a small shop, consisting of practically one building, having an equipment for light work only, electric transmission will not be found a paying investment, though an electric lighting dynamo will be a convenience; in an extensive railway shop plant, the installation of a central power station and electric transmission will always be found advisable. 3⅜ and 4 cols. respectively.—*Mech. Engr.*, Aug. 11th and 18th, 1900.

Transporters.—*The Temperley Patent Transporter.* Description of the principal exhibit of the Temperley Transporter Company, of London, at the Champ de Mars, in Paris, being a model representing their patent Transporter, of the Travelling Tower type, recently completed at the company's works, and which is to be taken down and sent to a foreign port for discharging coal from steamers. 3½ cols.—*Engrs.' Gaz.*, Sept., 1900.

5. Machine Works, Shop and Foundry.

Machine Shops.—*The New Erecting Shop of the H. K. Porter Company.* The article, accompanied by illustrations and a plan, gives a concise description of an erecting shop furnished with longitudinal tracks, served by overhead cranes. ½ col.—*Rld. Gaz.*, June 22nd, 1900.

Machine Shops.—*The Commercial Organisation of the Machine Shop.* By Hugo Diemer. *III. The Production Department: Store Room Management.* The article was preceded in June and July by two papers of the same author, viz., "The Systematised Classification of Shop Orders," and "The Production Department: Bills of Material." 6⅝ cols.—*Engrg. Mag.*, Aug., 1900.

6. Machine Tools.

Machine Tools.—*Some American Machine Tools.* The article describes various machine tools exhibited by Messrs. Charles Churchill & Co., of Leonard Street, London, E.C., at the recent Electric Traction Exhibition, comprising a Universal Milling Machine, and a Boring and Turning Mill, the former made by the Cincinnati Milling Machine Company, the latter by the Bullard Company, U.S.A., and also a Universal 24-in. Shaping Machine, built by the Potter & Johnston Company, of Pawtuckett. (Ill.) 1½ col.—*Mech. Engr.*, Aug. 4th, 1900.

—— *Some British Milling Machines.* By Alfred Herbert. The author defines the operation of milling as the cutting of metals by means of rotary multiple-toothed cutters, the great field for these machines being on repetition work, and adds that without them the economical manufacture of such articles as the sewing machine, the rifle, the typewriter, the cycle, and many other mechanical appliances would have been impossible. (Ill.) 9 cols.—*Cassier's Mag.*, Aug., 1900.

—— *Some Special Tools.* Description of some new tools constructed by Messrs. J. B. Stone & Co., 135, Finsbury Pavement, London, E.C., including a chain mortising machine, a tube-cutting machine, a belt-lacing machine, and a railway wagon pinching bar. (Ill.) 2 cols.—*Mech. Engr.*, Aug. 4th, 1900.

—— *Design and Construction of Machine Tools.* (Continued.) The present instalment deals with the Fellows' Gear Shaper, the operations of the gear shaper and its distinctive features. 5⅜ cols.—*Mech. Engr.*, Aug. 18th, 1900.

—— *Fellows' Gear Shaper.* Description of a gear shaper which has for its object the production of a tooth more correct in shape than can be produced by milling, at a less cost, and with greater rapidity. The inventor of the tool calls in question the accuracy of the miller for gear cutting, maintains that even if correct initially the process of hardening may produce deformation, and that the manner of cutting is such as to produce excessive gear, and claims that in his tool—which, it cannot be denied, is a very clever machine—all these defects are absent. (Ill.) 1¼ col.—*Engr.*, Aug. 31st, 1900.

—— *The Victoria Gear Cutter.* Description of a powerful new type of gear manufactured by Messrs. Gould & Eberhardt, of Newark, New Jersey, U.S.A., and cutting spur gear up to 33 ins. diameter and 9 ins. face without further attention to the setting. (Ill.) 1½ col.—*Am. Mfrr.*, Aug. 16th, 1900.

—— *Pneumatic Riveting and Drilling Tools in Shipyards and Boiler Works.* Descriptions of some American tools manufactured by the New Taite Howard Pneumatic Tool Co., Ltd., and the S. A. Woods Machine Co., of Boston, Mass., U.S.A. 1 col.—*Mar. Engr.*, Aug. 1st, 1900.

—— *Pneumatic Tools by the International Tool Co.* Description of various labour-saving devices of American design, manufactured by the above-named company, with headquarters at 9, Bridge Street, London, S.W.; among them a "Little Giant" piston air drill, or No. 2 drilling machine; a "Little Giant" single spindle reversible piston air-boring machine, a pneumatic hammer, a pneumatic motor as applied to chain-hoists, etc. (Ill.) 2½ cols. —*Steamship*, Sept., 1900.

—— *The Vincennes Exhibits.* By Warren E. Weinsheinner. Description of the interesting American exhibits in the United States Machinery Building at the annexe of the Paris Exhibition at Vincennes, which was the only place ready to run on the opening day,

April 14th, as the exhibits were not all in working order until May 10th, 1900. (Ill.) 2 cols.—*Am. Machy.*, Aug., 1900.

Machine Tools.—*More Early Milling Machines.* By E. G. Parkhurst. The author deals with the earlier kind of these machines and their special features. (Ill.) 2½ cols.—*Am. Mach.*, June 21st, 1900.

—— *The Paris Exposition—IX.* This instalment of the editor's correspondence is devoted to the description of a milling machine exhibited by Messrs. Smith & Coventry, of Manchester, at the Paris Exhibition, and having a range of feed from '005 to '10 per rotation of spindle. 4 cols.—*Am. Mach.*, Aug. 16th, 1900.

7. Refrigeration and Cold Storage.

8. Miscellaneous.

Air Ship.—*The Ascension of Count Zeppelin's Airship.* Description of the very interesting ascension-experiment carried out on July 2nd, with the great airship of Count Zeppelin on the shores of Lake Constance. (Ill.) 1⅝ col.—*Sci. Am.*, Aug. 11th, 1900.

Calculating Machine.—*An Ingenious Calculator.* Description of a calculator remarkable for its simplicity and ingenuity, which greatly simplifies division and multiplication, invented by Chen Ling Chang, of 57, Holanyen Street, Macao. (Ill.) 1 col.—*Sci. Am.*, July 28th, 1900.

Calorimeter.—*McInne's Separating and Wire Drawing Calorimeter.* Description of a new form of separating and wire drawing calorimeter, which is being introduced by T. S. McInnes & Co., of 41 and 42, Clyde Place, Glasgow, and for which the manufacturers claim some special features. (Ill.) 2½ cols.—*Mech. Engr.*, Aug. 4th, 1900.

China.—*Openings for Mechanical Engineers in China.* By Lord Charles Beresford. The author describes the conditions and opportunities of the country, and expresses the belief that there will be openings in the near future for engineers in connection with railway work, mining, and other branches, and suggests advertisements in the Anglo-Chinese papers. (Ill.) 10½ cols.—*Cassier's Mag.*, Aug., 1900.

Stoneworking Machinery.—*Diamond Circular Sawing Machine.* By M. Powis Bale, M.I.Mech.E. The author alludes to the many failures of attempts to utilize the diamond in cutting hard stone, owing to the difficulty of fixing the beam ends at the periphery of the saw, and describes a machine, invented by Mr. George Anderson, of Carnoustie, N.B., solving the problem successfully. (Ill.) 1½ cols.—*Stone Trds. Journ.*, Aug. 1900.

MINING AND METALLURGY.

1. Coal and Coke.

Collieries.—*The Collieries of the Ebbw Vale Company.* The introductory article deals with the geological and chemical characteristics of the strata which contain the coal and mine for which Ebbw Vale, north-west of Monmouthshire, is so noted. The second article describes the collieries themselves. 6½ cols.—*Ir. & Coal Trds. Rev.*, July 27th, 1900.

—— *The Collieries of Kebao, Tonking.* Description of collieries belonging to the French Société de Kebao, situated on the island of that name, in the Bay of Tai-Tsi-Long, close to the coast, almost at the bottom of the Gulf of Tonking, and at an equal distance from the town of Haiphong and from that of Moncay, opposite the Chinese frontier. 2½ cols.—*Iron & Steel Trds. Rev.*, Aug. 2nd, 1900.

Coal Mining.—*The Carnegie Ore Waggons Outdone.* Description of the 50-ton waggons of the Schoen Pressed Steel Company, which have almost revolutionised the mineral traffic of the American railways within the past four years, and which are now exhibited at Paris. (Ill.) 2 cols.—*Ir. & Coal Trds. Rev.*, Aug. 3rd, 1900.

—— *The Coal Basin of Michigan.* By A. C. Lane. The author gives a description, accompanied by a map, of the extent of the coal deposits, their geological peculiarities and development. 2½ cols.—*Engrg. & Min. Journ.*, June 30th, 1900.

Coal Mining.—*Suggestions for Improved Coal Mining Accident Statistics.* By F. L. Hoffman. The author analyses and discusses the various methods of compiling such statistics, and suggests important improvements. 4½ cols.—*Engrg. & Min. Journ.*, June 2nd, 1900.

2. Copper.

3. Gold, Silver and Gems.

Gold and Silver Mines.—*The Cochiti District, New Mexico.* Description of a comparatively new mining district, situated in a direct line 35 miles due west from Santa Fé, in the Jernez range of mountains. The mines are located on the eastern slope, at an elevation ranging from 7,500 to 8 000 ft., the known good ore-bearing veins being confined to an area of about 3 by 4 miles in extent, though veins which, so far as known, are barren of good ore are found on every side outside the small producing area. 2½ cols.—*Engrg. & Min. Journ.*, Aug. 25th, 1900.

4. Iron and Steel.

Iron-Ore Mining.—*A successful Method of Mining Iron Ore used at the Pewabic Mine, Michigan.* By Dr. M. P. Hulst. Extract from a paper read before the Engineer's Society of Western Pennsylvania, U.S.A. Description of a very successful method of mining ore by a system of caving, devised by Mr. E. F. Brown, of the Pewabic Mine, situated in the Manominee range, and lying within short distance of the Chagrin mine. This system has been in operation for a period of three years, and about 600,000 tons of iron ore have been extracted from the points in the mine, where it has been found advantageous to make use of this method exclusively. 1⅛ col.—*Iron and Coal Trds. Rev.*, Aug. 31st, 1900.

Iron and Steel.—*Iron and Steel at the Paris Exhibition.* The article contains a very interesting and concise description of the various exhibits of the iron and steel trades at the Paris Exhibition; and is preceded by an introduction commenting on the causes of the disappointing character of the *British Exhibition.* (Ill.) 33 cols.—*Supplement Ir. and Coal Trds. Rev.*, Aug. 10th, 1900.

Ironworks.—*Messrs. Davey, Paxman and Co.'s Standard Ironworks, Colchester.* Description of the works of a company, who devote practically all their attention to the manufacture of steam engines and boilers, air-compressing machinery, mining and pumping plants, etc. 2½ cols. and 2½ cols. respectively.—*Elec. Engr.*, Aug. 24th and 31st, 1900.

—— *The Dayton Lubricating Centre Plate.* Description of a lubricating centre-plate, manufactured by the Dayton Malleable Iron Company, under the patent owned by them. The frictional resistance of this type of plate is less than ¼ of those of dry plates. (Ill.) 1 col.—*Am. Engr. & Rld. Journ.*, Aug. 1900.

Smelting.—*Blast Furnace Smelting by Water Gas.* By Capt. C. C. Longbridge, M.Inst.M.E., M.I. Mech.E., etc. The author, who more than four years ago strongly advised the use of producer gas for smelting, though without making many converts, now repeats his advice of using gas as fuel, since the Dellwick Flerscher process of producing water-gas has placed upon the market a superior fuel excellently adapted for roasting, calcining, and for reverberatory and open hearth smelting. 2 cols.—*Engr.*, Aug. 17th, 1900.

Steel Casting.—*Evolution of Steel Casting.* Abstract from a paper entitled "l'Etat Actuel des Mouillages d'Acier," by M. Tissot, civil engineer, read before the International Congress of Mining and Metallurgy, held in connection with the Paris Exhibition. The author points out that although the first steel castings made their appearance 50 years ago, it is only during the last few years that they have been produced in such quantities as to permit of their manufacture being regarded as one of the triumphs of metallurgy, and then describes the most approved methods now in use. 1¾ col.—*Am. Mftrr.*, Aug. 16, 1900.

—— *Steel Castings.* Interesting description of the present condition of the industry, which commenced only

50 years ago, and by which castings of the most complicated forms are produced, that, moreover, stand the effect of shocks, replacing advantageously ordinary castings on the one hand, and expensive forgings on the other. 1¾ col.—*Mech. Wrld.*, Aug. 24th, 1900.

Steel Manufacture.—*The Taylor-White Process of Treating Steel.* Detailed description of a series of tests made with the object of showing the properties of lathe tools treated by the Taylor-White process. (Ill.) 4½ cols.—*Am. Mfrr.*, Aug. 16th, 1900.

—— *The Taylor-White Process.* Description of a new, greatly-improved process of manufacturing tool-steel at Bethlehem, of which, however, until the patents are secured, the chief features are kept secret. 1¾ cols.—*Engrg. Rcd.*, Aug. 4th, 1900.

—— *The Taylor-White Tool Steel Process of the Bethlehem Steel Co.* This is an account of a new method invented jointly by the consulting engineer and the engineer of tests of the Bethlehem Steel Co., for the manufacture of a tool steel that may be used at cutting speeds two to four times greater than those possible with other steels; the important features of the process, however, although patents are pending, are kept secret. 1½ col.—*Engrg. News*, Aug. 9th, 1900.

—— *The Real Fuel Ratio in the Cupola.* Abstract of a paper read before the American Foundrymen's Association. The article discusses the question as to which is the appropriate amount of metal to be melted with a ton of coke. 2 cols.—*Mech. Engr.*, Aug. 4th, 1900.

—— *Cupola Practice in Bessemer Steel Works.* By S. M. Rodgers. The article deals with the circumstances and conditions governing the proper manipulation of the cupola in Bessemer steel works. (Ill.) 1½ col.—*Iron & Steel Trds. Rev.*, Aug. 17th, 1900.

Steel Rails.—*The Life of Steel Rails.* The article does not enter into theoretical considerations, but merely classifies carefully collated facts from which the opinions expressed by the writer are deduced. It is pointed out that in the case of railways the chief limiting consideration which determines the amount of work that can be obtained from steel rails, or their life, is the thickness of metal that can be worn off the face of such rail with a due consideration to safety; while in the case of tramways, or street railways, in which the ordinary vehicular traffic runs on the same level as the track, does not depend so much upon the amount of wear to the rail itself as on the length of time the street paving on which these rails are laid lasts. 4½ cols.—*Engr.*, July 27th, 1900.

5. Mining and Mining Methods.

Mines.—*Mines and Miners.* The article, which is a first instalment, points out that prior to Queen Victoria's accession, there existed no legislation for the safety of miners, then describes the first step, *i.e.*, the Public Inquiry of 1840-43, and the Report of the Royal Commission regarding Employers of Children, Apprenticeship, Indescriminate Mixing of the Sexes in Mines. (To be continued.) 4½ cols.—*Engrg.*, July 20th, 1900.

—— *Mines and Miners.* This, the second instalment, deals with the Confirmatory Evidence from Witnesses, of the horrible hardships of children in the mines, the testimony of the children themselves, the conditions in Derbyshire, Yorkshire, Lancashire, Durham, and Northumberland and Scotland. (To be continued.) 2½ cols.—*Engrg.*, Aug. 3rd, 1900.

—— *The Fourth Era of the Leadville Mining District.* By Thomas Tonge. The author gives an interesting description of this district, which is unquestionably the most important in Colorado, having furnished within the last twenty-one years precious metals to the value of $250,000,000, and divides its history into four eras, the first being that of placer mining in California Gulf, the second beginning with the discovery, about 1879, of rich lead carbonates running high in silver; the third dating from the decline of the price of silver, culminating in 1893 with the closing of the Indian mints to the coinage of silver and the repeal of the silver purchasing clauses in the Sherman Act of the U.S.A., while the fourth may be called the composite era, in which gold, silver, lead, copper, zinc, and bismuth are profitably mined. (Ill.) 11 pp.—*Engrg. Mag.*, Sept., 1900.

Mine Equipment.—*Neuville Pit of the Grand-Manbourg Sablonnière Colliery, Belgium.* The author records his experiences of a visit to this colliery, and describes the Reumaux safety apparatus for the prevention of over-winding, together with other interesting appliances. (Ill.) 1¾ col.—*Coll. Guard.*, June 1st, 1900.

Mining.—*Canada as a Future Competitor in Coal and Iron.* The article deals with the vast mineral and metallurgical resources of the Dominion of Canada, and points out that arrangements are now in progress which are likely before long to place Canada into a front rank. 2¼ cols.—*Ir. & Coal Trds. Rev.*, Aug. 24th, 1900.

6. Miscellaneous.

Metallurgy.—*The Crystalline Structure of Metals.* By J. A. Ewing, F.R.S. and Walter Rosenham, B.A. Abstract of a second paper on the subject, read before the Royal Society, May 31st, 1900. The first section of the paper describes experiments made in the hope of observing under the microscope the process of recrystallisation in strained iron; while the second section deals with the changes in the crystalline structure which go on in lead and other metals at comparatively low temperatures. 4 cols.—*Mech. Engr.*, Aug. 4th, 1900.

Thermit-Welding.—*The Generation of Intense Heat through the Combustion of Aluminium.* By S. B. Archdeacon. Description of the highly interesting discovery of Dr. Hans Goldschmidt, of Essen, Germany, that by means of the combustion of aluminium, which produces a heat second only to that of the electric arc, chemically pure metals can be obtained, and welding of steel rails, etc., can be carried on in a very effective and economical manner. (Ill.) 4½ cols.—*Engrg. & Min. Journ.*, Aug. 25th, 1900.

MUNICIPAL ENGINEERING.

1. Gas Supply.

Gas Manufacture.—*The Construction and Working of Inclined Retorts.* By W. R. Herring, of Edinburgh. Abstract of a paper read before the meeting of the North British Association of Gas Managers. 9½ cols.—*Journ. of Gas Lghtng.*, Aug. 7th, 1900.

Gas Lamps.—*The Scott-Snell Self-Intensifying Gas Lamps.*—Description of a gas lamp, invented by Mr. C. Scott-Snell, which will enable the gas engineer, it is claimed, to change the character of any street gas-lamp, from an ordinary 60-candle light, to one of 300-candle power or more, without any additional pipes, without any extra cost for "power," and without disturbing a single underground connection. (Ill.) 3 cols.—*Journ. of Gas Lghtng.*, Aug. 14th, 1900.

Gasholders. — *The Guide-Framing of Gasholders.* Translation of a paper by Mr. Hacker, of Berlin, in abstract in which the author dwells on the uncertainty as to the distribution of a wind on the ordinary guide-framing, and proposes remedies based on mathematical calculation. 4 cols.—*Journ. of Gas Lghtng.*, June 5, 1900.

2. Sewerage.

Sewage.—*The Result of Bacterial Sewage Treatment.* Extract from a paper read before the Engineers' Club of Philadelphia by Mr. William Easby, Jr., of the University of Pennsylvania, explaining the septic tank contact-bed and coal filter system, summarising especially the work carried on in the British Isles. 3½ cols.—*Engrg. Rcd.*, June 25, 1900.

—— *Bacterial Sewage Disposal during the Past Year.* Abstract of a paper by Mr. Thudichum before the Association of Municipal and County Engineers, in which the author reviews the latest improvements and alterations in the bacterial system, all of which refer to details, however, and no change in principle has to be recorded. The paper is followed by a digest of the ensuing discussion. 9¾ cols.—*Engrg Rcd.*, Aug. 11, 1900.

3. Streets and Pavements.

Paving.—*Economics in Street Paving. I.* Report of a lecture delivered by Mr. S. Whinery before the College of Civil Engineering, Cornell University, reprinted

from the "Transactions" of the Association of Civil Engineers of the University. (To be continued.) 8½ cols. —*Engrg. Rcd.*, Aug. 11, 1900.

4. Water Supply.

Aqueduct.—*The Preliminary Ellinement of the New Croton Aqueduct.* By E. Sherman Gould. The author describes the preliminary scientific work undertaken with the object of locating the centre line of the new aqueduct. 2½ cols. *Engrg. News*, May 31st, 1900.

Mains.—*New Rising Main, Pittsburg, Pa., U.S.A.* The article gives a description of a 48-inch riveted steel force main, 3,930 ft. long, and of the expansion joint and manholes. (Ill.) 1⅝ cols.—*Engrg. Rcd.*, June 9th, 1900.

—— *The Disinfection of Water Mains with Chloride of Lime.* The article is a reproduction of a contribution to the *Surveyor*, London, describing the manner in which the mains at Maidstone were disinfected after the outbreak of the epidemic of typhoid fever. 1½ cols.—*Engrg. News*, June 21st, 1900.

Water Purification.—*Operation of the Water-Settling and Filtration Plant at Albany, N.Y.* The article describes the results of nearly a year's operation of the water-purification plant at Albany, N.Y., U.S.A. —the actual period is 319 days—during which a total of 3,817,200,000 gals. of water were filtered, or on an average of nearly 12,000,000 gals. a day, which is the largest amount of water ever filtered by a single American plant in so short a time. 3⅝ cols.—*Engrg. News*, Aug. 9th, 1900.

—— *The Purification of Trade Wastes.* By Mr. R. A. Tatton. Abstract of a paper read before the Institution of Civil Engineers on the purification of water after its use in manufactories, and of a report by Mr. W. O. E. Meade-King on a series of experiments on the purification of waste water from industrial establishments made by Mr. Tatton. 6½ cols.—*Engrg. Rcd.*, Aug. 25th, 1900.

Water Filtration.—*The Filtration of Water for Public Use.* Discussion of this subject by the American Society of Civil Engineers during their meeting held at the Institution of Civil Engineers, Great George Street, London. 4 cols.—*Journ. of Gas Lghtng.*, July 24th, 1900.

Water Supply.—*Wooden Water-Supply Piping.* Description of a wooden pipe system constructed on the estate, in North Wales, of Mr. Harry Buddicom, M.I.Mch.E., Penbedw, Mold, for bringing water down to a farm for driving a mill, and for pumping by hydraulic means a supply for nine different farms, the distance for the farthest away being 3,000 yds., while the height above the level of the pumping engine reaches to 200 ft. The pipe was built at the rate of 15 yds. per day by three men. All the tools for constructing it were made by the estate carpenter and a blacksmith, and cost some £2. (Ill.) 1½ cols.—*Engrg.*, July 20th, 1900.

Waterworks.—*Godalming Waterworks.* Description of the new waterworks at the old-fashioned and historically interesting town of Godalming, in Surrey, constructed according to the plans prepared by Messrs. Shone & Ault, and consisting of a new pumping station with improved machinery, of two duplicate reservoirs of 200,000 gallons aggregate capacity, and of arrangements increasing the supply by collecting a flow of excellent water from the lower green seen cropping out close to the surface near the pumping station. 2½ cols. and 4⅝ cols. respectively.—*Engrg.*, Aug. 3rd and 17th, 1900.

—— *The Jersey City Waterworks.* The article deals with the new waterworks at Jersey City, N.J., U.S.A., in course of construction under a single contract, which calls for a watershed and storage reservoir sites capable of collecting and delivering at all times 70,000,000 gals. of water daily, and a reservoir and conduit with a preliminary capacity of 90,000,000 gals. daily, to be increased later to 70,000,000 gals. daily by the raising of the dam at the intake and the addition of another line of steel pipe. (Ill.) 7 cols.—*Engrg. Rcd.*, July 21st, 1900.

—— *The White Plains Waterworks.* Description of the waterworks at White Plains, N.J., about 10 miles from the city limits of Greater New York, having a population of about 9,000 and containing many handsome country residences. The plant, which was erected by a private company, was in 1895 acquired by the village, and it was decided to greatly enlarge its size and to improve it. The pump-house and reservoir will have a capacity of about 100,000,000 gals. and a flow line 75 ft. above the pump foundations. (Ill.) 4¼ cols.—*Engrg. Rcd.*, Aug. 25th, 1900.

Waterworks.—*Cleaning Silted Pipes.* Abstract of a paper by Mr. J. R. Wilkinson, read before the Colliery Managers' Association, in which the author deals with the removal of the more or less plastic deposit usually deposited from cold water in rising mains of pumps or pipes, through which they may have to pass. The experiment was made with a line of pipes about 200 yds. in length. (Ill.) 1 col.—*Iron & Coal Trds. Rev.*, Aug. 31st, 1900.

5. Miscellaneous.

Refuse Destructors.—*Baker's Refuse Destructor.* Description of the refuse destructors of Messrs. Joseph Baker & Sons, of Willesden Junction, in which the refuse is dried and the noxious gases distilled out in a separate chamber before being cremated. (Ill.) ⅔ col.—*Publ. Hlth. Engr.*, Sept. 1st, 1900.

NAVAL AND MILITARY ENGINEERING.

1. War Vessels.

Battleships.—*The Battleship of the Future.* By F. C. Goodall, M.I.N.A., and A. C. Holzapfel. Abstract of a paper read before the Congress of Naval Architects, Paris, in which the authors suggest that now that armour plates of a certain thickness can be made, which would be practically impenetrable by any artillery hitherto constructed, it might be advisable to construct battleships entirely coated by armour, so as to be practically impenetrable. This, it is true, would mean an enormous increase in size and displacement, but a displacement of 31,000 tons would not exceed that of the *Great Eastern* or the *Oceanic*. 3 cols.—*Steamship*, Aug., 1900.

Foreign Navies.—*The Imperial Japanese Navy.* By Rear-Admiral C. C. P. Fitzgerald, R.N. The author, who has recently returned from Japan, and had an opportunity of inspecting Japanese ships and dockyards, summarises his experience, and gives an interesting description of the condition of the Japanese Navy. 13½ cols.—*Cassier's Mag.*, Aug. 1900.

High Speed War Vessels.—*High Speed in War Vessels.* The article gives a concise description of the protected cruiser *Variag*, built at Cramps' Yard, Philadelphia, Penn., U.S.A., for the Russian Government, having a speed of 23 knots, and the famous British torpedo-boat *Viper*, with a mean speed of 36·58 knots. 1½ col.—*Sci. Am.*, Aug. 11th, 1900.

Submarine Boats.—*On Immersion Rudders.* The author points out that of all the questions connected with submarine navigation, that of the means of immersion is the most important, and that, so far, the steering apparatus has offered the greatest difficulty, he then proceeds to inquire into the causes. 3 cols.—*Revue Technique*, July 25th, 1900.

War Vessels.—*The Sloop of War "Wampanoag."* By Chief Engineer B. F. Isherwood, U.S. Navy. Description of a vessel which, as the author says, though long forgotten, was really the precursor of the modern so-called cruiser, and which, though a novelty at the time, had qualities and capabilities that still make it an object of interest both for example and instruction. 13 cols.—*Cassier's Mag.*, Aug., 1900.

2. Equipment.

3. Armour Plates, Guns and Ammunition.

Guns.—*War Material at the Paris Exhibition* The article, after dwelling on the fact that exhibits of war material are necessarily kept within distinct limits of expediency, and that the very best types adopted in the armaments of a nation are necessarily kept more or less secret, is devoted almost exclusively to a description of Hotchkiss guns. (Ill.) 3 cols.—*Engr.*, Aug. 31st, 1900.

Guns.—*The Howell Disappearing Carriage.* Description of a disappearing gun carriage, which is now undergoing tests at Sandy Hook, belonging to that type in which the gun is mounted on the extremity of two gun-levers, that rotate about a fixed axis, while to the other extremity of the levers is attached a counterweight, which brings the gun from the loading to the firing position, and assists in checking recoil when the gun is fired. 1⅛ col.—*Sci. Am.*, Aug. 25th, 1900.

—— *Building Big Guns.* By James Eastus Price. Short description of gun-making as carried on in the Washington Navy Yard, where, according to the author, "the most complete gunshop in the world is located." 2½ cols.—*Mod. Machy.*, Aug., 1900.

—— *Notes on the Construction of "Long Cecil,"* a 4·1-in. Rifled Breechloading Gun in Kimberley, during the siege of 1899—1900. By Mr. Edward Goffe. Abstract of a paper read before the Inst. of Mech. Engrs., describing the highly interesting methods of construction of this famous gun, the joint product of the late Mr. Labram and the author. (Ill.) 5 cols. (To be continued.)—*Mech. Progress*, Aug., 1900.

RAILWAY WORK.

1. Motive Power and Equipment.

Air Brake Cars.—*The Correspondence Schools Air Brake Cars.* Description of six new cars for air brake instruction built for the International Correspondence Schools at Scranton, Pa., U.S.A., which brings up the number of these cars to twelve completely and even magnificently equipped cars, which owing to the rapidly increasing growth of these schools will probably have to be still further increased in the very near future. (Ill.) ⅝ col.—*Ry. Age*, Aug. 17th, 1900.

Locomotives.—*Compound Locomotive, Southern Railways of Italy.* Description of one of the most remarkable locomotives at the Paris Exhibition. It is a four-cylinder compound engine with piston valves. It is carried on six coupled wheels and a four-wheeled bogie with an unusually long wheel base. The coupled wheels are 6ft. 4in. diameter. The cylinders are 15in. and 22·44in. diameter, with a stroke of 25·6in. The grate is 7ft. 2in. long by 4ft. 11in. wide, giving a surface of 35 square feet. There are 273 tubes 13ft. 2in. long. The cylinders, two inside and two outside, are all arranged in front of the smoke box, which is itself of great length, nearly half as long as the boiler barrel. (Ill.) ¼ col.—*Engr.*, July 27th, 1900.

—— *Four-Wheel Coupled Locomotive at the Paris Exhibition.* Description of a locomotive exhibited by the well-known Société Français des Constructions Mécaniques, better known as the Anciens Etablissement Cail, built at the company's large works at Denain for the Orleans Railway. (Ill.) 1¾ col.—*Engrg.*, Aug. 3rd, 1900.

—— *Exposition of* 1900. *Compound Express Locomotive with auxiliary apparatus by Messrs. Krauss & Co., Munich.* The article describes a locomotive exhibited in the German section of the Paris Exhibition at Vincennes, specially interesting from the fact that its motor efforts can be easily regulated according to the task to be performed at a given time. (Ill.) 4 cols.—*Génie Civil*, Aug. 11th, 1900.

—— *Four Cylinder Locomotive.* Description of a locomotive constructed at the works of the Glasgow and South-Western Railway Company, Kilmarnock, from the designs of Mr. James Manson, which has been in service since April, 1897, and up to July 31st—this year—has run 141,011 miles. (Ill.) 1½ col.—*Engrg.*, Aug. 10th, 1900.

—— *American Freight Locomotive.* Description of an engine which at present surpasses in weight and tractive power all locomotives ever built, being one of three constructed at the Pittsburg Locomotive Works for the Pittsburg, Bessemer and Lake Erie Railroad. (Ill.) ½ col.—*Engrg.*, Aug. 3rd, 1900.

—— *Exhaust and Draught in Locomotives.* Digest of a report by Mr. Edouard Sauvage submitted to the International Railroad Congress dealing with all countries, except the United States, Sweden, Norway, Denmark and Russia, and taking into consideration the relative values of fixed and variable exhaust nozzles and smoke stacks, arrests and feed-water heating devices, mainly reproduced from the *Railroad Gazette.* 6½ cols.—*Mech. Engr.*, Aug. 11th, 1900.

Locomotives.—*The Heaviest Locomotive in the World.* Description of what at present is the heaviest locomotive in the world, constructed, along with a sister engine, at the Pittsburg Locomotive Works, and to be used on the Pittsburg, Bessemer and Lake Erie Railroad for hauling ore and iron at moderate but regular speeds; the net hauling capacity being 7,847 tons on straight and level track, while the tractive force at one-fourth of the adhesive weight is 56,300 lbs., the total weight of the engine being 250,300 lbs., and the total weight of engine and tender in working order 391,400 lbs. (Ill.) 2½ cols.—*Mech. Engr.*, Aug. 4th, 1900.

Locomotive Works.—*Some Interesting Features of the Shenectady Locomotive Works.* Description of the equipment of the above-named locomotive works, at Shenectady, New York, which in 1899 built 355 complete locomotives for domestic and foreign use, of which 63 were of Shenectady compound type. To accomplish the task of building this number of engines, almost one complete locomotive per day, 2,500 men were employed. (Ill.) 4½ cols.—*Am. Machy.*, Aug., 1900.

2. New Projects and Lines in Construction.

Railways.—*The Transbaikal Hei-Lun-Zagan Railway.* When the original plan of a line from Strjetensk to Chabarowsk, following to a great extent the Schilka and the Amur, was abandoned, a new connection between the Transbaikal and Vladivostock was adopted, passing through Manchuria, and consisting of three sections. The first of these connects the Transbaikal Railway with the Chinese province of Hei-Lun-Zagan, and the article describes the details of construction of this first section. 2½ cols.—*Engrg.*, Aug. 10th, 1900.

3. Permanent Way and Fixtures.

Railway Stations.—*The Southern Terminal Station at Boston, U.S.A.* Description of what is said to be, and most probably is, the largest and best-equipped railway station in the world, designed and constructed by Messrs. Westinghouse, Church, Kerr and Co., and contains many novel and interesting features. 3½ cols.—*Engrg.*, Aug. 31st, 1900.

Tunnelling.—*The East Boston Tunnel.* The article describes a double-track street-railway tunnel in course of construction under Boston Harbour, under the auspices of the Boston Transit Commission. (Ill.) 1½ col.—*Engrg. Rcd.*, June 2nd, 1900.

4. Transportation and Conducting.

5. Miscellaneous.

Railways.—*The Funicular Railway of Montmartre, at Paris.* Description of the funicular railway running up to the top of the hill of Montmartre, at Paris, and opened to traffic on July 13th. It runs alongside the stairs which lead from the Rue Foyatier to the Rue Lamark, and offers to passengers an opportunity of reaching the top at a minimum price, *i.e.*, one penny, while the descent costs one-halfpenny only. The difference of height between the two terminal points is 36·6 metres and of length in a bee-line 85 metres. 2½ cols.—*Génie Civil*, Aug. 11th, 1900.

—— *Siberia and its Railway.* Digest of the important and interesting report on this great engineering enterprise by Mr. Cooke, British Commercial Agent in Russia, recently issued by the Foreign Office. 2½ cols.—*Chamb. of Com. Journ.*, Aug., 1900.

—— *Special Means of Transport at the Paris Exhibition.* This first instalment gives a full description of the Paris Metropolitan Railway, of which nearly 12 kilometres have been opened to traffic, the total length projected being 62 kilometres. (Ill.) 9½ cols. To be continued.)—*Dingler's Polytech. Journ.*, 1900.

STREET RAILWAYS AND TRAMWAYS.

1. Trolley Lines.

Electric Traction.—*Sunderland Electric Tramways.* Description of a section of the Sunderland Corporation tramway lines, which was inspected on Aug. 15 by the inspectors of the Board of Trade and the Local Government, and was immediately afterwards opened to traffic. (Ill.) 2 cols.—*Elec. Rev.*, Aug. 24, 1900.

—— *Sunderland Tramways.* Description of the first section of the Sunderland Tramways, to be worked electrically, which was opened to traffic on Aug. 15th, after having been tested by the Board of Trade and Local Government Board Inspectors. The whole work had been placed in the hands of Mr. J. F. C. Snell, borough electrical engineer. (Ill.) 3 cols.—*Elec. Engr.*, Aug. 31st, 1900.

—— *Description of the Blackpool and Fleetwood Tramroad and Generating Stations.* By Tom G. Lumb, M.I.C.E. As the title indicates, it is a description of a very popular tramroad 8½ miles in length, passing through charming scenery, and built by Messrs. Dick, Kerr & Co. It carried during the first 12 weeks of its existence 550,000 passengers, realising over £12,000, and this with ten open cars running. 4½ cols.—*Elec. Engr.*, Aug. 10th, 1900.

—— *Norwich Electric Tramways.* Description of a plant erected by the New General Traction Company. (Ill.) 4½ cols. and 2½ cols. respectively.—*Elec. Rev.*, July 27th and Aug. 3rd, 1900.

—— *Gloucester Electricity Works.* Description of the Gloucester Corporation Electricity Works. (Ill.) 5 cols.—*Elec. Rev.*, Aug. 3rd, 1900.

—— *Notes on Electric Traction.* By. A. H. Binyon. Abstract of a paper read before the Society of Engineers, June 11th, 1900, in which the author endeavours to justify his view that the trolley wire system is the most efficient and economical, the least expensive in first cost and upkeep, easily maintained and repaired, and a safe and reliable system. 4 cols. and 3½ cols. respectively.—*Mech. Engr.*, Aug. 18th and 25th, 1900.

Trolleys.—*The Pearson Wing Trolley.* Descriptions of two inventions of Mr. James T. Pearson, of Burnley, designed to remove difficulties connected with trolleys for electric tramways. The first of these, the wing trolley, is designed to make it more easy to get the trolley wheel on the trolley wire, and to make it more difficult for the trolley wheel to leave the wire on a curve; the other invention, called the "Traveller," has for its object the prevention of accidents of the kind, which have occurred in consequence of the rope from the trolley head hanging loose. (Ill.) ⅝ col.—*Elec. Engr.*, Aug. 24th, 1900.

2. Surface Contact Lines.

3. Miscellaneous.

Electric Traction.—*The Bois de Boulogne Combined Trolley and Surface Contact Tramway.* Description of a tramway line built on the system of M. Vedovelli, extending from the Neuilly Gate at Paris to Saint Cloud, the surface contact being ordered by the administration to be used at the gates, and where the overhead line might detract from the beauty of the scenery. 3 cols.—*Elec. Rev.*, Aug., 17, 1900.

—— *From Steam to Electric Traction on a Chicago Railway.* Description of the Southside Elevated Railway's conversion into an electric road. It was opened as a steam line in the year 1892, and in the following year extended to run into the Chicago Exhibition grounds. After the Exhibition the traffic decreased, the line passed into the Receiver's hands, and was bought by the company that now owns it, and converted into an electric line, with the result of a remarkable decrease in expenditure and an increase in traffic. 2 cols.—*Lightning*, Aug. 9, 1900.

—— *The Central London Railway.* Description of this new line, which, according to the author of the article, is interesting to Americans for a number of special reasons, patriotic, financial and engineering, the patriotic reason, of course, being that all the mechanical and electrical appliances are American. (Ill.) 4½ cols.—*Engrg. Recd.*, Aug. 4th, 1900.

Electric Traction.—*Underground Electric Railway, London. Methods of Construction.* Description of the methods adopted in sinking the shafts and boring the tunnels of the Central London Railway, which were almost entirely bored through London clay, which greatly reduced the engineering difficulties. (Ill.) 2½ cols.—*Sci. Am.*, Aug. 11th, 1900.

—— *The Paris Metropolitan Railway. General Description of the Track Projected: Detailed Description of the Stretch Completed.* By A. Dumas. This is a very interesting and instructive article on the Paris underground electric railway, the first portion of which was opened to public traffic on July 19th this year, accompanied by numerous illustrations and working drawings. 27⅝ cols.—*Génie Civil*, July 21st, 1900.

—— *The Metropolitan Railway, Paris.* Description of an electrically equipped underground line, which, when completed, will be about 26 miles in length, and of which 8½ miles were opened to the public on July 19th, 1900. (Ill.) 2½ cols.—*Elec. Rev.*, Aug. 24th, 1900.

—— *What Pressure is Dangerous on Electric Railways with Overhead Trolley Wires.* By William Rung, C.E., of the firm of Brown, Boveri & Co., Switzerland. Description of the results of some highly interesting experiments conducted by Prof. H. F. Weber, of the Zürich Polytechnic, to determine whether 750 volts is dangerous, and 500 volts should be the limit for current in trolley wires; the experiments resulted in showing that all pressures between 100 and 1,000 volts are equally dangerous, and that if 500 volts are permitted, there should be no objection to 750 volts. 2½ cols.—*Nature*, Aug. 23rd, 1900.

TRADE AND COMMERCE.

1. Commerce and Trade.

Machinery Trade.—*Austria-Hungary's Machinery Tool Trade in 1899.* The article is a digest of the statistical information on the subject published by the Austrian Government, giving in detail the data regarding imports and exports; the value of the former amounted to 46,014,254 florins, as against 43,546,798 in 1898, while the value of the exports of machinery amounted to 14,371,792 florins. 3½ cols.—*Am. Mach.*, Aug. 9th, 1900.

2. Industries.

Industrial Depression.—*Industrial Depression and the Pig-Iron Reserve.* By George H. Hull. The author ascribes the industrial depression to an abnormal advance in the price of pig-iron, and suggests that the only possible way to bring iron under proper control is to accumulate in each of the iron-producing countries of the world a stock of pig-iron equal to several months' production; if this be done during the next few years, he thinks there will be no more periods of boom and no more periods of industrial depression, except such short temporary interruptions as may come from financial panics. 13½ pages.—*Engrg. Mag.*, Aug., 1900.

Porto Rico.—*The Industrial Development of the Island of Porto Rico.* By Albert W. Buel. The article dwells mainly on such lines of development as would show immediate, or quick, results, but above all there must be a general reform as regards education, for until the United States took over the government of the island, there was practically no public school system. (Ill.) 19 pages.—*Engrg. Mag.*, Aug. 1900.

Sugar Industry.—*Sugar Engineering in Cuba.* By E. Sherman Gould, M.Am.Soc.E. The author points out that it would be hard to find an industrial operation involving more scientific and engineering details than that of sugar-making, which stands fully abreast of iron and steel production, and then proceeds to give a brief sketch of the various processes through which, in particular, Cuban sugar cane passes, in order that its juice may be extracted and converted into "96 per cent. centrifugal." (Ill.) 13½ cols.—*Cassier's Mag.*, Sept., 1900.

REVIEWS.

Acetylene. A Handbook for the Student and manufacturer. By Vivian B. Lewes, F.I.C., Prof. of Chemistry, Royal Naval College, Greenwich; Chief Superintending Gas Examiner to the Corporation of the City of London, etc. 228 illus. 31*s.* 6*d.* nett. Westminster. Archibald Constable & Co., Ltd.

The developments in recent years of the manufacture of calcium carbide, and the rapid growth of the manufacture of apparatus for the production of acetylene gas, is a matter of common knowledge. The literature of the subject—at any rate as far as this country is concerned—has not kept pace, however, with these developments, and until the production of the above volume it is notorious that no text-book on the subject worthy of the name has been published in the English language, although France possesses three handbooks and Germany one. It is true that articles in serial form, such as a translation of Perrodil's "Le Carbure de Calcium et l'Acetylene," and Prof. Lewes' articles on Acetylene Generators, appeared in the pages of the *Progressive Age* and FEILDEN'S MAGAZINE respectively. The *Journal of Acetylene* has also recorded the march of events, but the want has been felt of a comprehensive volume which would contain a complete record of all the work that has been done both from the scientific and manufacturing standpoints.

In the volume before us Prof. Lewes has succeeded in tracing a concise history of the developments of acetylene along both these lines, a task by no means free from difficulty, taking into consideration the risks that might be run in overloading the technical side of the question with scientific researches, and thus removing the work from the pale of practical utility as far as the manufacturer of apparatus was concerned.

The opening chapter deals with the history of acetylene from its discovery by Edmund Davy, in 1836, to the introduction of commercial acetylene in 1895; the thorough manner in which the developments are traced, and the abundance of references to authorities, rendering it of the utmost value to the student working on the subject.

Chapter II is devoted to the preparation of the gas by laboratory methods, considering, in succession, (*a*) the formation of acetylene by the direct union of its constitutents; (*b*) by the incomplete combustion of gases containing hydrogen and carbon; (*c*) by passing organic vapours and gases through heated tubes; (*d*) by the chemical decomposition of organic compounds; (*e*) by the double decomposition of certain carbides in contact with water; and from a purely scientific standpoint, is perhaps one of the most interesting portions of the book.

In view of the unsatisfactory and meagre manner in which the subject of acetylene gas is treated in most of the chemical text books, Chapter II of Prof. Lewes' book will be read with pleasure, and prove of invaluable assistance to those whose time is too limited to undertake a research in the proceedings of chemical and other societies.

The properties of the gas are discussed in the third chapter, and a consideration of the chemical reactions brings to a close the purely scientific and not the least valuable portion of the work.

The practical utilisation of acetylene for lighting purposes was an impossibility while it depended on the earlier and more laborious methods of generation, and the recognition of the value of the electric furnace as an agent for the production of intense heat rendered the comparatively cheap manufacture of carbide of calcium possible. As a factor in the production of the gas the electric furnace therefore is important, and in Chapter V is a description of the various apparatus at present in use.

The subject of the methods and cost of production of calcium carbide is fully considered in the next chapter, in the course of which Prof. Lewes recommends, as a basis for the price of carbide, the unit of gas-producing power instead of, as hitherto, determining this by weight.

A worked example given by the author reduces the cost of production, under favourable circumstances, of one ton of packed carbide to £8 per ton. This is exclusive of carriage to the works where the carbide is to be decomposed and the gas distributed. When it is remembered that the present wholesale price of carbides is about £20 per ton, representing, according to the author, £2 per 1000 in the holder, the possibility of acetylene rivalling coal gas as an illuminant is out of the question. For the present, therefore, it is only in remote districts where coal gas is unobtainable that the true field for acetylene exists.

The remainder of the work is devoted to the construction and principles of the various forms of generators at present on the market, and to an appendix of useful data including the legal enactments of various countries with regard to carbide and acetylene, a list of English patents granted for generators and lamps with abstracts of the specifications.

Both author and publisher are to be congratulated on the excellent printing and clear illustrations, and altogether the work cannot fail to prove of immense value and interest to all who are scientifically interested or practically engaged in the acetylene industry.

Sketches of Engine and Machine Details. Wallace Bentley, M. Inst. M. E. Halifax: The Bentley Publishing Co. Price 2s. 6d.

In the preface, the author of this compact volume states that he issues it in consequence of the great success attained by his previous engineering publications. That this product of his pen will meet with a success commensurate with its value — which when we say that Mr. Wallace Bentley is a practical man who has succeeded in conveying a great deal of valuable information, that cannot fail to be of conspicuous assistance to the student-draughtsman—goes almost without saying. The only disadvantage discernible consists in the absence of any explanation as to the functions fulfilled by the machine parts, etc., without which no volume purporting to deal with machine design is complete, and hence does not enable us to justify its commendation to a beginner